

## ENGINE - 3.0L TD SERVICE INFORMATION

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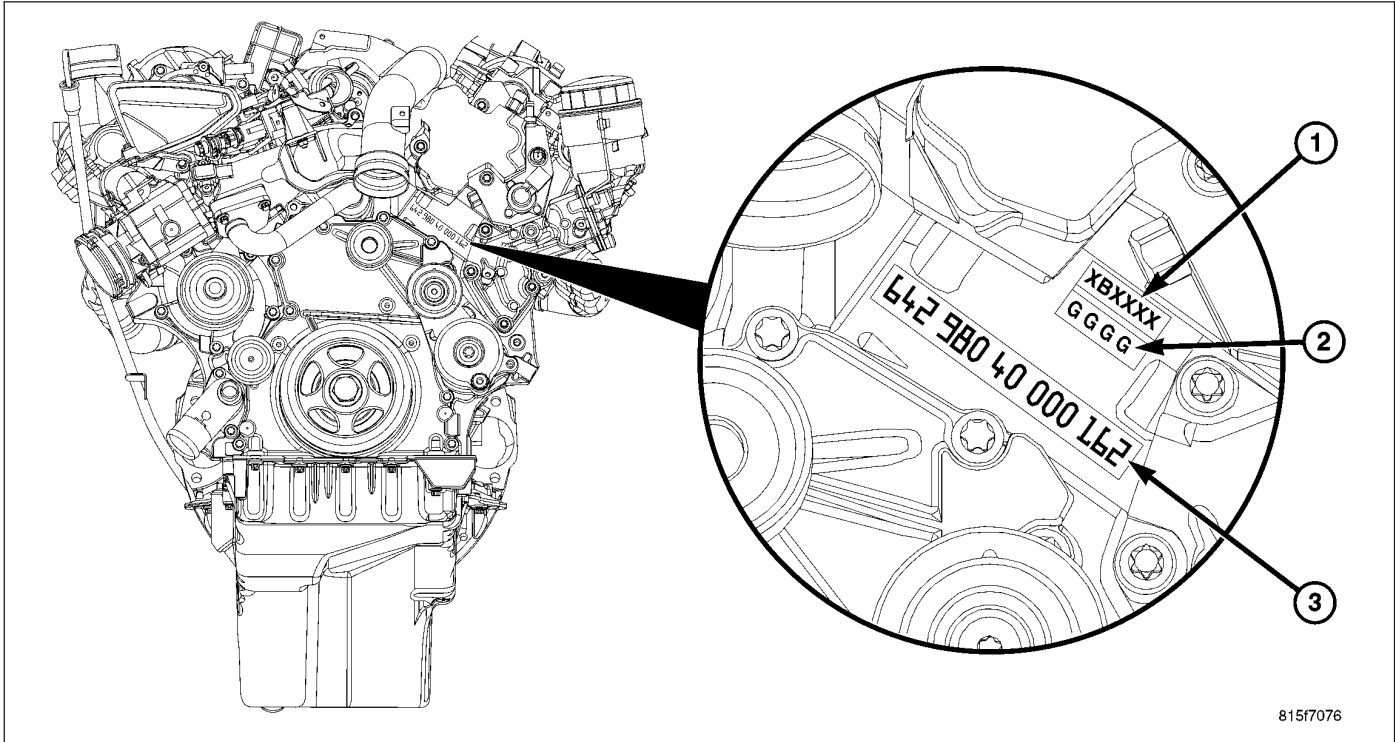
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## ENGINE - 3.0L TD SERVICE INFORMATION

### DESCRIPTION

#### 3.0L COMMON RAIL DIESEL ENGINE

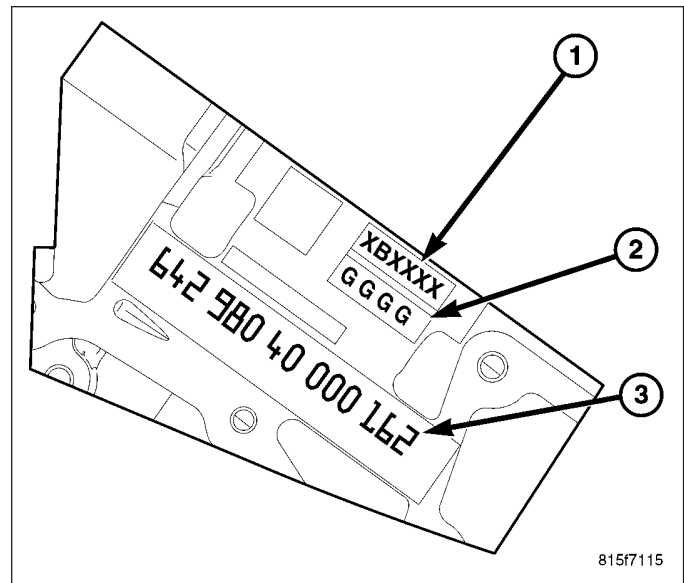


The 3.0L (183 C.I.D.) six - cylinder “common rail” direct injection engine is a 72°, overhead valve design. The engine utilize a cast aluminum cylinder block molded around cast iron piston sleeves. The engine has aluminum cross flow cylinder heads, four valves per cylinder, central injectors and dual overhead camshafts. The 3.0L is turbocharged, intercooled, and also equipped with a EGR cooler.

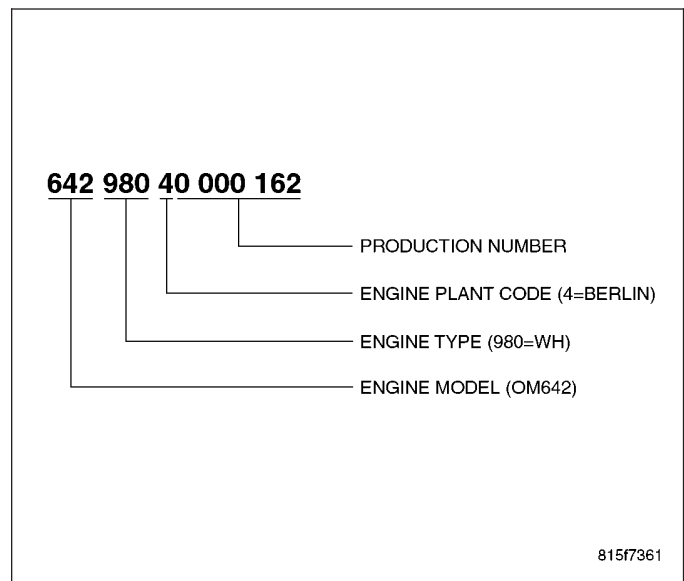
Additional features are:

- Finger Follower Actuated Valves with Hydraulic Adjusters
- Counter Rotating Balance Shaft
- Oil Jet Cooled Pistons
- Swirl Intake Ports
- Chain driven D.O.H.C. per bank of cylinders, with 4 valves per cylinder

The engine identification stamp (3) for the 3.0L is located on the left side of the engine block, below the high pressure pump along with the 4 digit main bearing identifying stamp (2) and the 6 digit cylinder bore identifying stamp (1).

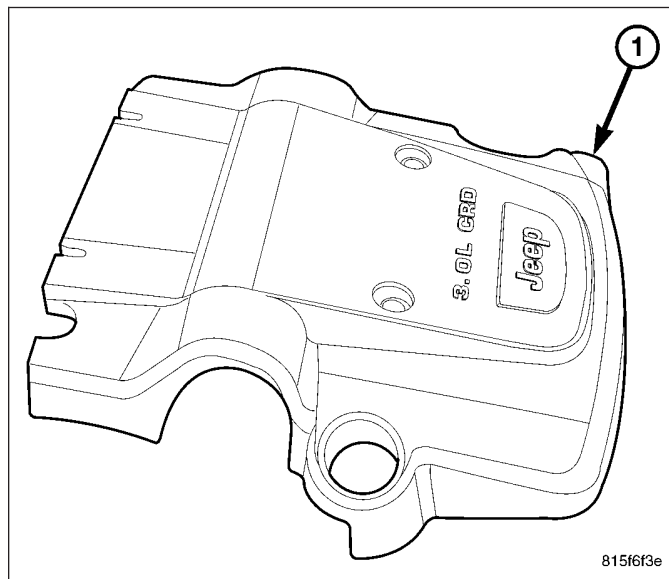


The engine identification number encompasses the production number, engine plant code, engine type and engine model.



## ENGINE COVER

The insulated engine cover (1) is made of composite material and used cosmetically to cover the top of the engine and greatly reduce engine noise. Three brackets secure the cover to the engine.



## DIAGNOSIS AND TESTING

### ENGINE DIAGNOSIS - MECHANICAL

CONDITION	POSSIBLE CAUSES	CORRECTION
LUBRICATING OIL PRESSURE LOW	<ol style="list-style-type: none"> <li>Low oil level.</li> <li>Oil viscosity thin, diluted or wrong specification.</li> <li>Improperly operating pressure switch/gauge.</li> <li>Relief valve stuck open.</li> <li>If cooler was replaced, shipping plugs may have been left in cooler</li> <li>Worn oil pump.</li> <li>Suction tube loose or seal leaking.</li> <li>Loose main bearing cap.</li> <li>Worn bearings or wrong bearings installed.</li> <li>Directed piston cooling nozzles under piston, bad fit into main carrier.</li> </ol>	<ol style="list-style-type: none"> <li>(a) Check and fill with clean engine oil. (b) Check for a severe oil leak, worn rings (burning oil), oil leaking from the turbocharger to the intake, or other root causes for low oil level.</li> <li>(a) Verify the correct engine oil is being used. (b) Look for reduced viscosity from fuel dilution.</li> <li>Verify the pressure switch is functioning correctly. If not, replace switch/gauge.</li> <li>Check/replace valve.</li> <li>Check/remove shipping plugs.</li> <li>Check and replace oil pump.</li> <li>Check and replace seal.</li> <li>Check and install new bearing. Tighten cap to proper torque.</li> <li>Inspect and replace connecting rod or main bearings. Check and replace directed piston cooling nozzles.</li> <li>Check directed piston cooling nozzles position.</li> </ol>

CONDITION	POSSIBLE CAUSES	CORRECTION
	12. Loose directed piston cooling nozzle.	12. Tighten directed piston cooling nozzle.
LUBRICATING OIL PRESSURE TOO HIGH	1. Pressure switch/gauge not operating properly.	1. Verify pressure switch is functioning correctly. If not, replace switch/gauge.
ENGINE BREATHER RESTRICTED	2. Engine running too cold. 3. Oil viscosity too thick. 4. Oil pressure relief valve stuck closed or binding	2. Coolant Temperature Below Normal 3. Make sure the correct oil is being used. 4. Check and replace valve.
LUBRICATING OIL LOSS	1. External leaks. 2. Crankcase overfilled. 3. Incorrect oil specification or viscosity. 4. Oil cooler leak 5. High blow-by forcing oil out the breather. 6. Turbocharger leaking oil to the air intake.	1. Visually inspect for oil leaks. Repair as required. 2. Verify that the correct dipstick is being used. 3. (a) Make sure the correct oil is being used. (b) Look for reduced viscosity from dilution with fuel. (c) Review/reduce oil change intervals. 4. Check and replace the oil cooler. 5. Check the breather tube area for signs of oil loss. Perform the required repairs. 6. Inspect the air ducts for evidence of oil transfer. Repair as required (slight oil residue is normal).
COMPRESSION KNOCKS	1. Air in the fuel system. 2. Poor quality fuel or water/gasoline contaminated fuel. 3. Engine overloaded. 4. Improperly operating injectors.	1. Identify location of air leak and repair. Do not bleed high pressure fuel system. 2. Verify by operating from a temporary tank with good fuel. Clean and flush the fuel tank. Replace fuel/water separator filter. 3. Verify the engine load rating is not being exceeded. 4. Check and replace misfiring/inoperative injectors.
EXCESSIVE VIBRATION	1. Loose or broken engine mounts. 2. Damaged fan or improperly operating accessories. 3. Improperly operating vibration damper 4. Improperly operating balance shaft 5. Improperly operating electronically controlled viscous fan drive. 6. Worn or damaged generator bearing. 7. Flywheel housing misaligned. 8. Loose or broken power component.	1. Replace engine mounts. 2. Check and replace the vibrating components. 3. Inspect/replace vibration damper. 4. Inspect/replace balance shaft. 5. Inspect/replace fan drive. 6. Check/replace generator. 7. Check/correct flywheel alignment. 8. Inspect the crankshaft and rods for damage that causes an unbalance condition. Repair/replace as required.

CONDITION	POSSIBLE CAUSES	CORRECTION
	9. Worn or unbalanced driveline components.	9. Check/repair driveline components.
EXCESSIVE ENGINE NOISES	1. Drive belt squeal, insufficient tension or abnormally high loading. 2. Intake air or exhaust leaks. 3. Excessive valve lash. 4. Turbocharger noise. 5. Gear train noise. 6. Power function knock.	1. Check the automatic tensioner and inspect the drive belt. Make sure water pump, tensioner pulley, fan hub, generator and power steering pump turn freely. 2. Refer to Excessive Exhaust Smoke (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING). 3. Adjust valves. Make sure the rocker arms are not bent. Replace bent or severely worn components. 4. Check turbocharger impeller and turbine wheel for housing contact. Repair/replace as required. 5. Visually inspect and measure gear backlash. Replace gears as required. 6. Check/replace rod and main bearings.

## SMOKE DIAGNOSIS CHARTS

The following charts include possible causes and corrections for **excess or abnormal** exhaust smoke. Small amounts of exhaust smoke (at certain times) are to be considered normal for a diesel powered engine.

EXCESSIVE BLACK SMOKE	
POSSIBLE CAUSE	CORRECTION
Air filter dirty or plugged.	Check and/or replace filter
Air intake system restricted.	Check entire air intake system including all hoses and tubes for restrictions, collapsed parts or damage. Repair/replace as necessary.
Air Leak in Intake System.	Check entire air intake system including all hoses and tubes for collapse, cracks, loose clamps and/or holes in rubber ducts. Also check intake manifold for loose mounting hardware.
Diagnostic Trouble Codes (DTC's) active or multiple, intermittent DTC's.	Refer to Powertrain Diagnostic Procedures Information.
Engine Control Module (ECM) has incorrect calibration.	Refer to Powertrain Diagnostic Procedures Information.
Exhaust system restriction is above specifications.	Check exhaust pipes for damage/restrictions. Repair as necessary.
Fuel grade is not correct or fuel quality is poor.	Temporarily change fuel brands and note condition. Change brand if necessary.
Fuel injection pump malfunctioning.	A DTC may have been set. If so, refer to Powertrain Diagnostic Procedures Information.
Fuel injector malfunctioning.	A DTC may have been set. Perform "Injector Classification Programming" using scan tool. Also refer to Powertrain Diagnostic Procedures Information and, Return Fuel Quantity Test.
Fuel injector lower washer doubled or missing.	Remove and inspect injector washer.
Fuel return system restricted.	Check fuel return lines for restriction.
Intake manifold restricted.	Remove restriction.



EXCESSIVE BLACK SMOKE	
POSSIBLE CAUSE	CORRECTION
Manifold Air Pressure (Boost) Sensor or sensor circuit malfunctioning.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information.
Turbocharger air intake restriction.	Remove restriction.
Turbocharger damaged.	Refer to Exhaust and Turbocharger Diagnostic Procedures
Turbocharger has excess build up on compressor wheel and/or diffuser vanes.	Refer to Exhaust and Turbocharger Diagnostic Procedures
Turbocharger wheel clearance out of specification.	Refer to Exhaust and Turbocharger Diagnostic Procedures

EXCESSIVE WHITE SMOKE	
POSSIBLE CAUSE	CORRECTION
Air in fuel supply: Possible leak in fuel supply side.	Inspect fuel system
Coolant leaking into combustion chamber.	Perform pressure test of cooling system.
Diagnostic Trouble Codes (DTC's) active or multiple, intermittent DTC's.	Refer to Powertrain Diagnostic Procedures Information.
In very cold ambient temperatures, engine block heater is malfunctioning (if equipped).	Refer to In-Block Heater
Engine coolant temperature sensor malfunctioning.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information. Also check thermostat operation.
Engine Control Module (ECM) has incorrect calibration.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information.
Fuel filter plugged.	Refer to Powertrain Diagnostic Manual for fuel system testing.
Fuel grade not correct or fuel quality is poor.	Temporarily change fuel brands and note condition. Change brand if necessary.
Fuel heater element or fuel heater temperature sensor malfunctioning. This will cause wax type build-up in fuel filter.	Refer to Fuel Heater Testing (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL HEATER - DIAGNOSIS AND TESTING).
Fuel injector malfunctioning.	A DTC should have been set. Perform "Injector Identification Programming" or "Cylinder Cutout Test" using scan tool to isolate individual cylinders. Also refer to Powertrain Diagnostic Procedures Information.
Fuel injector hold-down(s) loose.	Replace the copper washer(s)(shim) and torque to specifications.
Fuel injector protrusion not correct.	Check washer (shim) at bottom of fuel injector for correct thickness.
Fuel injection pump malfunctioning.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information.
Fuel supply side restriction.	Refer to Powertrain Diagnostic Manual for fuel system testing.
Intake manifold air temperature sensor malfunctioning.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information.
Intake manifold heater circuit not functioning correctly in cold weather.	A DTC should have been set. Refer to Powertrain Diagnostic Procedures Information. Also check heater elements for correct operation.



EXCESSIVE WHITE SMOKE	
POSSIBLE CAUSE	CORRECTION
Intake manifold heater elements not functioning correctly in cold weather.	A DTC should have been set if heater elements are malfunctioning. Refer to Powertrain Diagnostic Procedures Information.
Internal engine damage (scuffed cylinder).	Analyze engine oil and inspect oil filter to locate area of probable damage.
Restriction in fuel supply side of fuel system.	Refer to Powertrain Diagnostic Manual for fuel system testing.

EXCESSIVE BLUE SMOKE	
POSSIBLE CAUSE	CORRECTION
Dirty air cleaner or restricted turbocharger intake duct.	Check Air Cleaner Housing for debris and replace filter as necessary
Air leak in boost system between turbocharger compressor outlet and intake manifold.	Service charge air system.
Obstruction in exhaust manifold.	Remove exhaust manifold and inspect for blockage.
Restricted turbocharger drain tube.	Remove turbocharger drain tube and remove obstruction.
Crankcase ventilation system plugged.	Inspect oil separator system for function and clear drain back hole in cylinder head cover/intake manifold
Valve seals are worn, brittle, or improperly installed.	Replace valve stem oil seals
Valve stems and/or guides are worn.	Remove valves and inspect valves and guides.
Broken or Improperly installed piston rings.	Tear down engine and inspect piston rings.
Excessive piston ring end gap.	Remove pistons and measure piston ring end gap.
Excessive cylinder liner wear and taper.	Remove pistons and measure cylinder liner wear and taper.
Cylinder damage.	Remove pistons and inspect cylinder liner for cracks or porosity. Repair with new cylinder liner if necessary.
Piston damage.	Remove pistons and inspect for cracks, holes. Measure piston for out-of-round and taper.
Turbocharger failure.	Refer to Exhaust and Turbocharger Procedures

## STANDARD PROCEDURE

### FORM-IN-PLACE GASKETS AND SEALERS

There are numerous places where form-in-place gaskets are used on the engine. Care must be taken when applying form-in-place gaskets to assure obtaining the desired results. **Do not use form-in-place gasket material unless specified.** Bead size, continuity, and location are of great importance. Too thin a bead can result in leakage while too much can result in spill-over which can break off and obstruct fluid feed lines. A continuous bead of the proper width is essential to obtain a leak-free gasket.

There are numerous types of form-in-place gasket materials that are used in the engine area. Mopar® Engine RTV GEN II, Mopar® ATF-RTV, and Mopar® Gasket Maker gasket materials, each have different properties and can not be used in place of the other.

#### MOPAR® ENGINE RTV GEN II

Mopar® Engine RTV GEN II is used to seal components exposed to engine oil. This material is a specially designed black silicone rubber RTV that retains adhesion and sealing properties when exposed to engine oil. Moisture in the air causes the material to cure. This material is available in three ounce tubes and has a shelf life of one year. After one year this material will not properly cure. Always inspect the package for the expiration date before use.

### **MOPAR® ATF RTV**

Mopar® ATF RTV is a specifically designed black silicone rubber RTV that retains adhesion and sealing properties to seal components exposed to automatic transmission fluid, engine coolants, and moisture. This material is available in three ounce tubes and has a shelf life of one year. After one year this material will not properly cure. Always inspect the package for the expiration date before use.

### **MOPAR® GASKET MAKER**

Mopar® Gasket Maker is an anaerobic type gasket material. The material cures in the absence of air when squeezed between two metallic surfaces. It will not cure if left in the uncovered tube. The anaerobic material is for use between two machined surfaces. Do not use on flexible metal flanges.

### **MOPAR® GASKET SEALANT**

Mopar® Gasket Sealant is a slow drying, permanently soft sealer. This material is recommended for sealing threaded fittings and gaskets against leakage of oil and coolant. Can be used on threaded and machined parts under all temperatures. This material is used on engines with multi-layer steel (MLS) cylinder head gaskets. This material also will prevent corrosion. Mopar® Gasket Sealant is available in a 13 oz. aerosol can or 4oz./16 oz. can w/applicator.

## **FORM-IN-PLACE GASKET AND SEALER APPLICATION**

Assembling parts using a form-in-place gasket requires care but it's easier than using precut gaskets.

Mopar® Gasket Maker material should be applied sparingly 1 mm (0.040 in.) diameter or less of sealant to one gasket surface. Be certain the material surrounds each mounting hole. Excess material can easily be wiped off. Components should be torqued in place within 15 minutes. The use of a locating dowel is recommended during assembly to prevent smearing material off the location.

Mopar® Engine RTV GEN II or ATF RTV gasket material should be applied in a continuous bead approximately 3 mm (0.120 in.) in diameter. All mounting holes must be circled. For corner sealing, a 3.17 or 6.35 mm (1/8 or 1/4 in.) drop is placed in the center of the gasket contact area. Uncured sealant may be removed with a shop towel. Components should be torqued in place while the sealant is still wet to the touch (within 10 minutes). The usage of a locating dowel is recommended during assembly to prevent smearing material off the location.

Mopar® Gasket Sealant in an aerosol can should be applied using a thin, even coat sprayed completely over both surfaces to be joined, and both sides of a gasket. Then proceed with assembly. Material in a can w/applicator can be brushed on evenly over the sealing surfaces. Material in an aerosol can should be used on engines with multi-layer steel gaskets.

## **REPAIR DAMAGED OR WORN THREADS**

**CAUTION: Be sure that the tapped holes maintain the original center line.**

Damaged or worn threads can be repaired. Essentially, this repair consists of:

- Drilling out worn or damaged threads.
- Tapping the hole with a special Heli-Coil Tap, or equivalent.
- Installing an insert into the tapped hole to bring the hole back to its original thread size.

## **HYDROSTATIC LOCK**

**CAUTION: DO NOT use the starter motor to rotate the crankshaft. Severe damage could occur.**

When an engine is suspected of hydrostatic lock (regardless of what caused the problem), follow the steps below.

1. Disconnect the negative cable(s) from the battery.
2. Inspect air cleaner, induction system, and intake manifold to ensure system is dry and clear of foreign material.
3. Place a shop towel around the fuel injectors to catch any fluid that may possibly be under pressure in the cylinder head. Remove the fuel injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL).

**CAUTION: DO NOT use the starter motor to rotate the crankshaft. Severe damage could occur.**

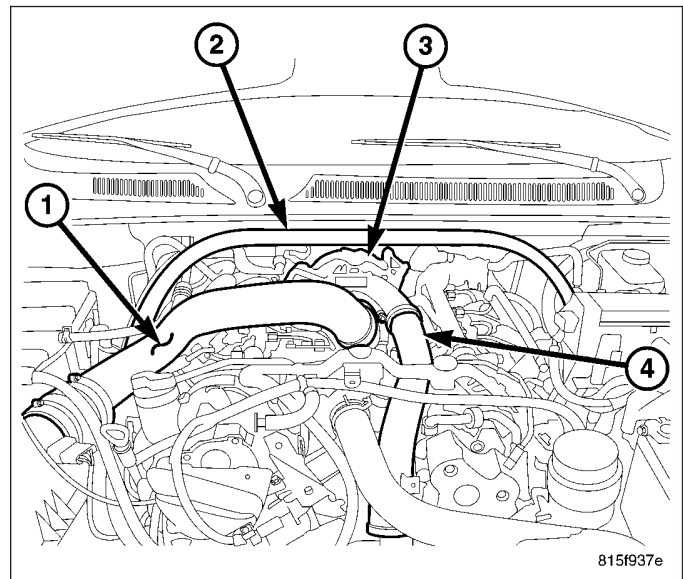
4. With all injectors removed, rotate the crankshaft using the crankshaft.

5. Identify the fluid in the cylinders (coolant, fuel, oil, etc.).
6. Be sure all fluid has been removed from the cylinders.
7. Repair engine or components as necessary to prevent this problem from occurring again.
8. Squirt a small amount of engine oil into the cylinders to lubricate the walls. This will prevent damage on restart.
9. Install fuel injectors (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - INSTALLATION).
10. Drain engine oil. Remove and discard the oil filter.
11. Install the drain plug. Tighten the plug to 50 N·m (37 ft. lbs.) torque.
12. Install a new oil filter and tighten to 10 N·m 88 in. lbs.) torque.
13. Fill engine crankcase with the specified amount and grade of oil (Refer to LUBRICATION & MAINTENANCE/ FLUID TYPES - SPECIFICATIONS).
14. Connect the negative cable(s) to the battery.
15. Start the engine, allow to warm, turn engine off and check for any leaks. (Refer to 14 - FUEL SYSTEM - WARNING).

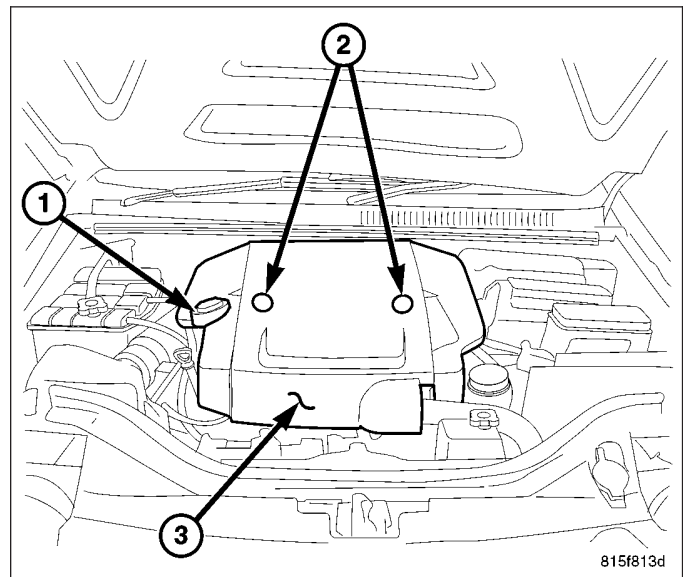
## REMOVAL

### 3.0L COMMON RAIL DIESEL ENGINE

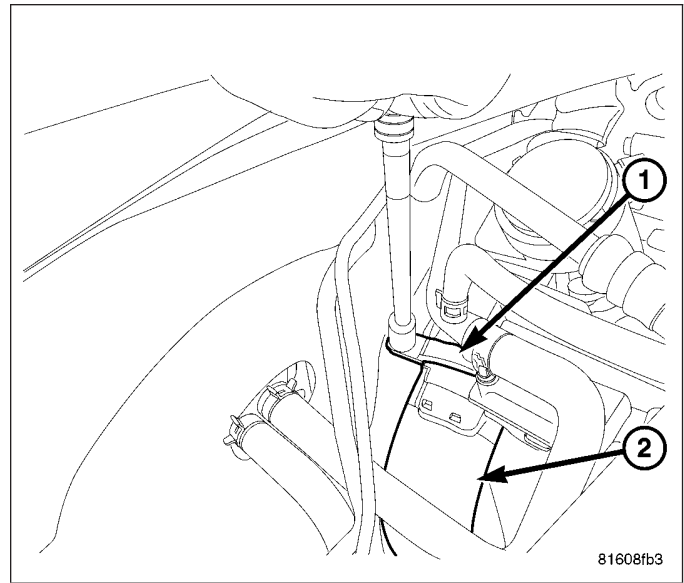
1. Disconnect negative battery cable.
2. Drain cooling system.
3. Evacuate air conditioning.
4. Remove the strut tower support (2).



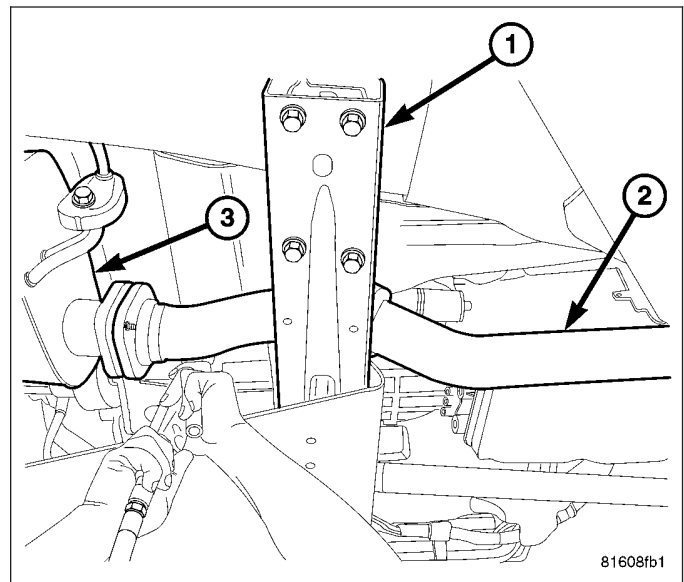
5. Remove engine cover (3).
6. Remove air cleaner housing (Refer to 9 - ENGINE/ AIR INTAKE SYSTEM/AIR CLEANER HOUSING - REMOVAL).



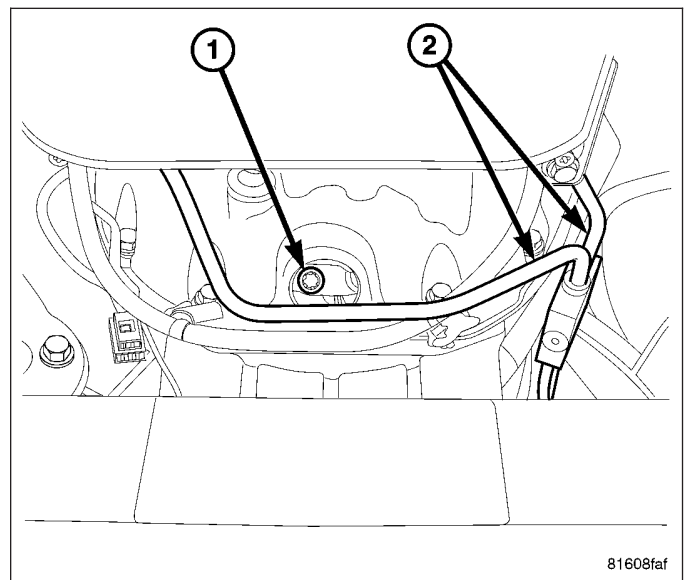
7. Remove lower catalytic converter to upper catalytic converter clamp (1) behind right cylinder head.
8. Raise and support the vehicle.
9. Remove front splash shield.
10. Drain power steering at cooling fan, cap lines and set aside.



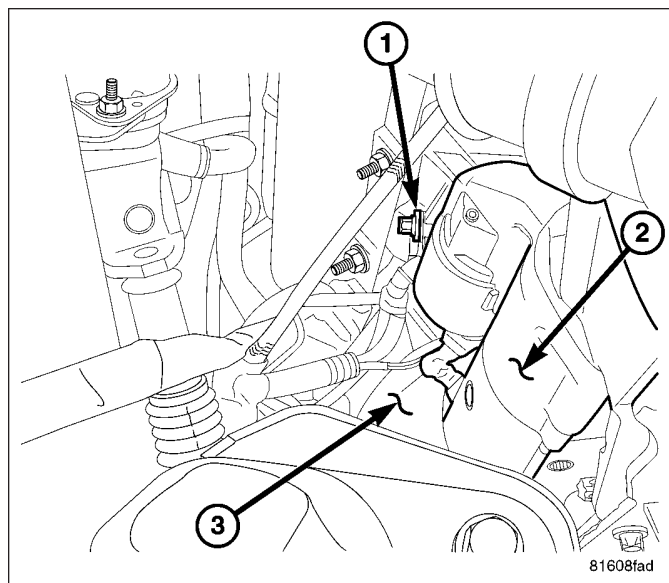
11. Remove catalytic converter clamp from exhaust pipe (2).
12. Remove transfer case splash shield.
13. Disconnect the front exhaust pipe (2) at muffler (3).
14. Remove the catalytic converter and front exhaust pipe (2).



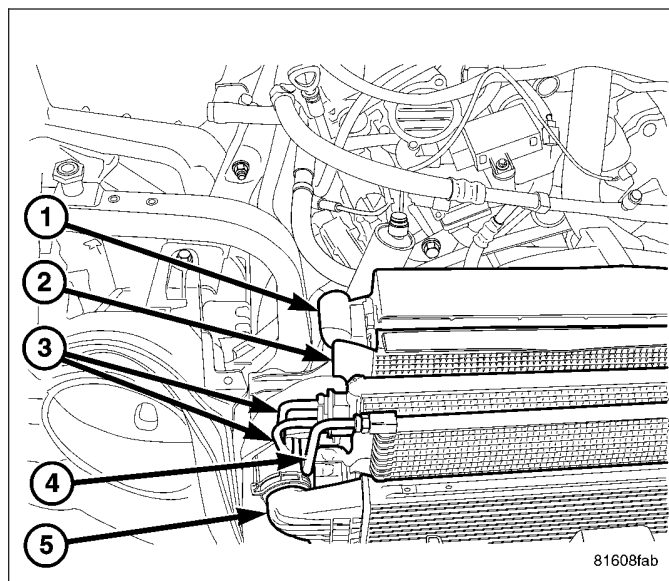
15. Paint mark the flex plate to torque converter relation and remove the torque converter bolts (1) through the access hole.



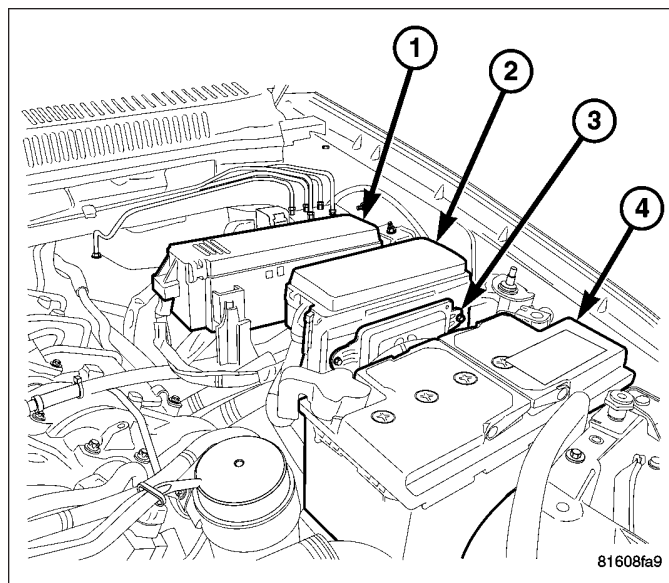
16. Support the transmission with a transmission jack and remove the transfer case cross over bolts from frame.
17. Carefully lower the transmission enough to gain access to the upper transmission to engine mounting bolts, and remove accessible bolts.
18. Raise transmission, install the transfer case cross over bolts, and remove transmission jack.
19. Disconnect the transmission wiring harness at transmission and route wiring harness toward the starter.
20. Remove remaining transmission to engine bolts.
21. Disconnect the engine ground strap (1) in front of the starter (2).



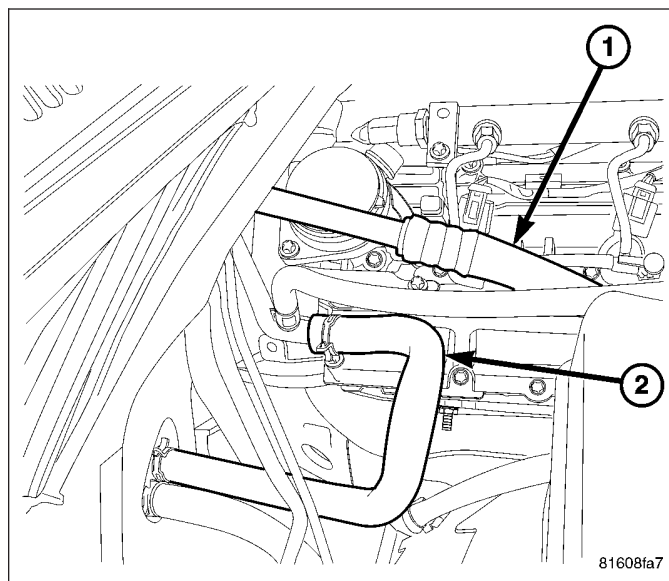
22. Loosen both engine mount through bolts.
23. Remove the lower radiator hose.
24. Remove the front axle housing (Refer to 3 - DIFFERENTIAL & DRIVELINE/FRONT AXLE - C200FE - REMOVAL).
25. Lower the vehicle.
26. Remove the front grille and radiator upper core support. Remove the hood latch and position aside.
27. Remove the front core support brackets.
28. Remove the charge air inlet hose (5).
29. Remove the charge air outlet hose (5).
30. Disconnect the power steering reservoir hose to pump, at the reservoir.
31. Disconnect the suction/discharge lines at the condenser and accumulator.
32. Disconnect the transmission cooler (3) and power steering cooler lines (4) at the coolant module.
33. Position the radiator (1) deflectors aside and remove coolant module to core support fasteners.
34. Remove cooler module assembly.



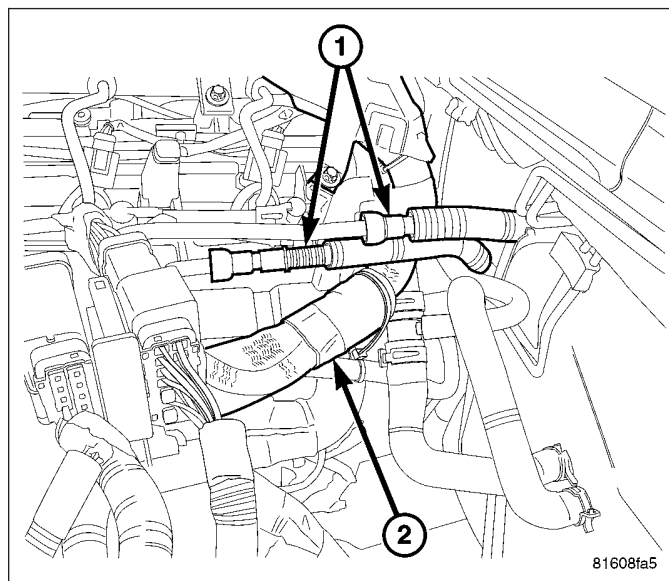
35. Remove the battery (4) and tray.
36. Remove the power distribution center (PDC) (1) from the bracket and remove the bracket.
37. Disconnect the PCM (3) and route the engine wiring harness on top of the engine.
38. Route engine wiring aside and disconnect the starter wiring.
39. Unplug air conditioning (AC) compressor wiring at compressor, route the transmission harness forward, and place the harness on top of the engine.



40. Disconnect the generator wiring harness, and position aside.
41. Disconnect the vacuum hose at the vacuum pump, and set aside.
42. Disconnect the wiring harness connectors from the PDC.
43. Disconnect the heater hose (2) at cooler tube on the right cylinder head.
44. Disconnect the coolant by-pass hose (2) at the cooler tube on the right cylinder head.
45. Disconnect the coolant hose, at the outer housing, by the generator.
46. Disconnect the A/C lines (1) at the expansion valve.
47. Remove the engine cover mounting bracket.
48. Remove the transmission oil level indicator tube retaining bolt.

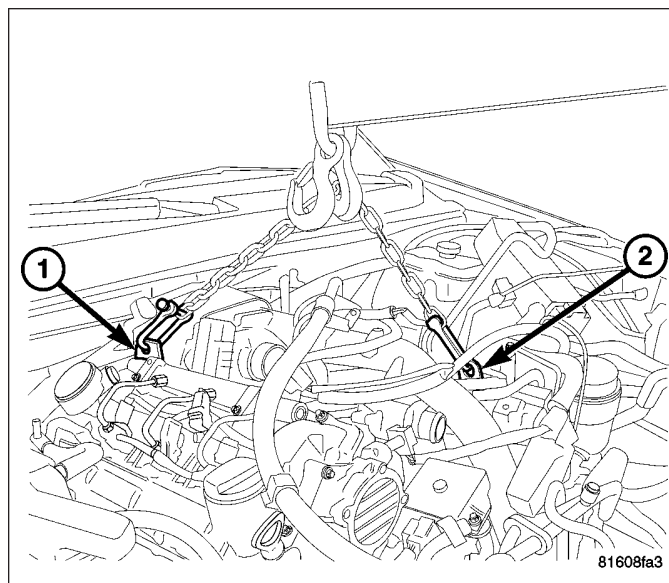


49. Loosen front axle vent tube from wiring harness and position aside.
50. Disconnect the fuel lines from the fuel rail using special tool #6507.



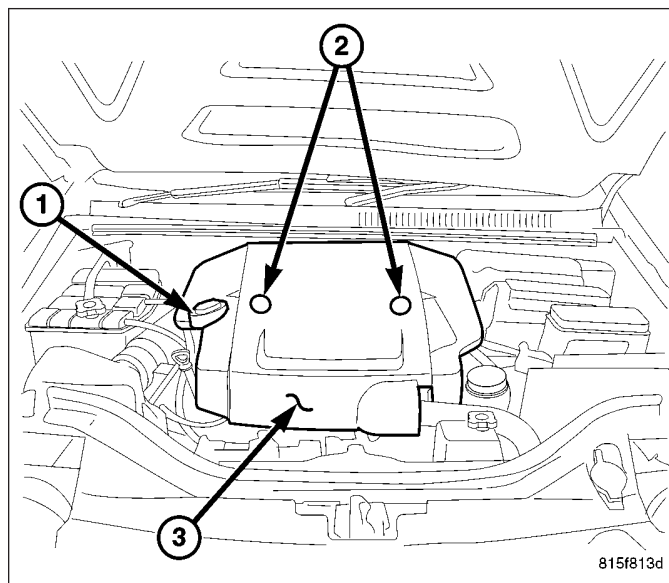


51. Remove upper turbocharger heat shield.
52. Connect engine lift chain to engine lift fixtures.
53. Support the transmission with a floor jack.
54. Lift the weight of the engine off of the engine mounts (1,2).
55. Remove right engine mount from engine.
56. Remove left engine mount from engine.
57. Remove engine from vehicle.



## ENGINE COVER

1. Remove the engine oil cap (1).
2. Remove the fasteners (2).
3. Pull the cover (1) forward and away from the rear mounting brackets.

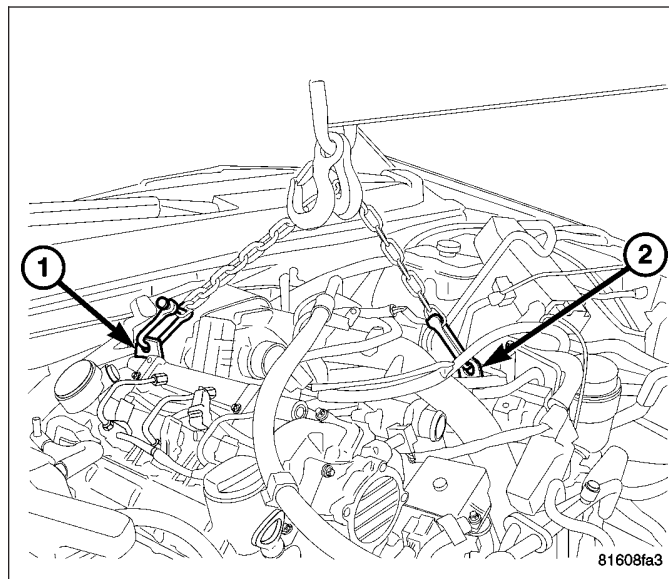




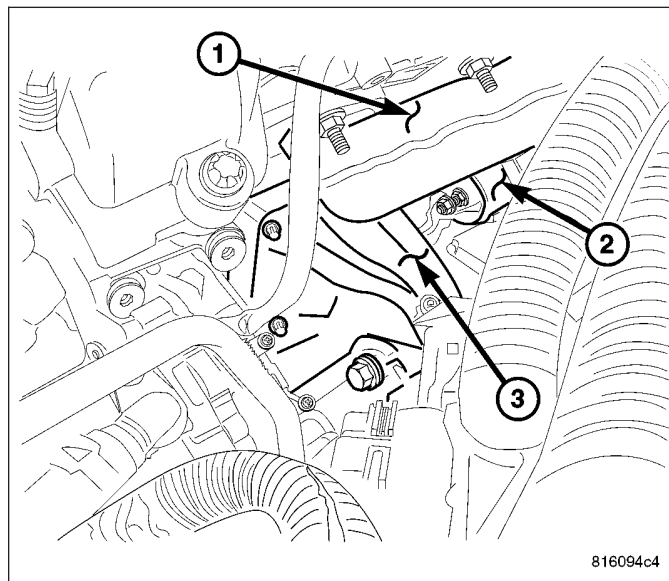
## INSTALLATION

### 3.0L COMMON RAIL DIESEL ENGINE

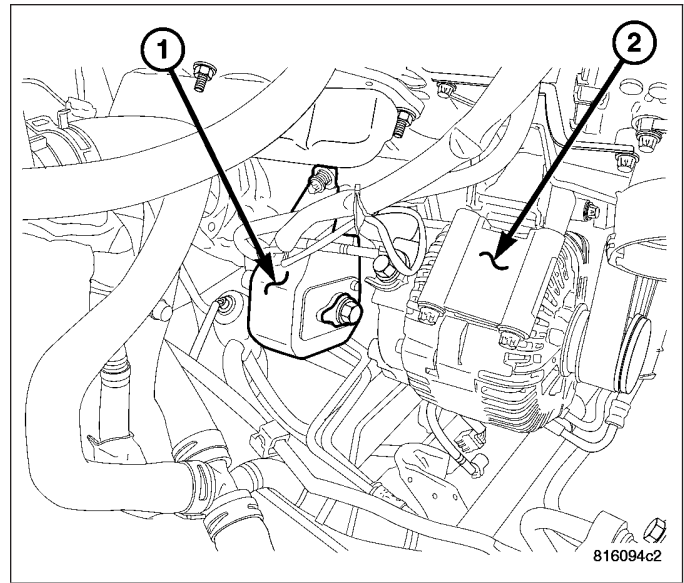
1. Carefully align the engine assembly in the engine bay area and align with the transmission, **Do Not** lower the engine.



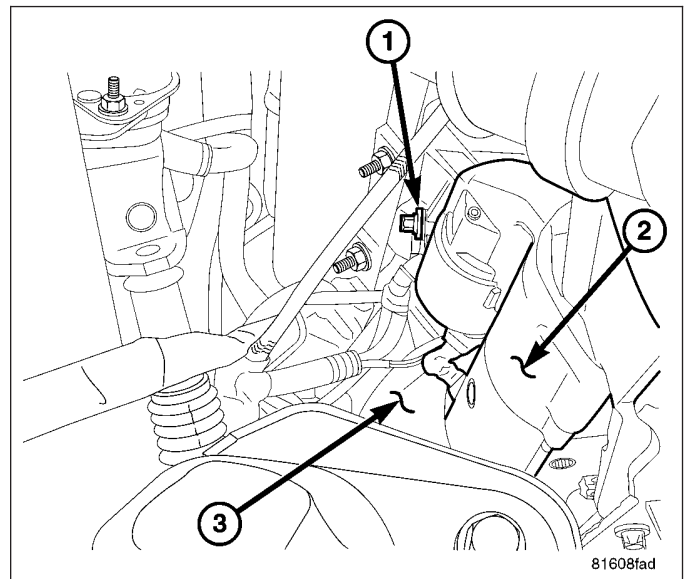
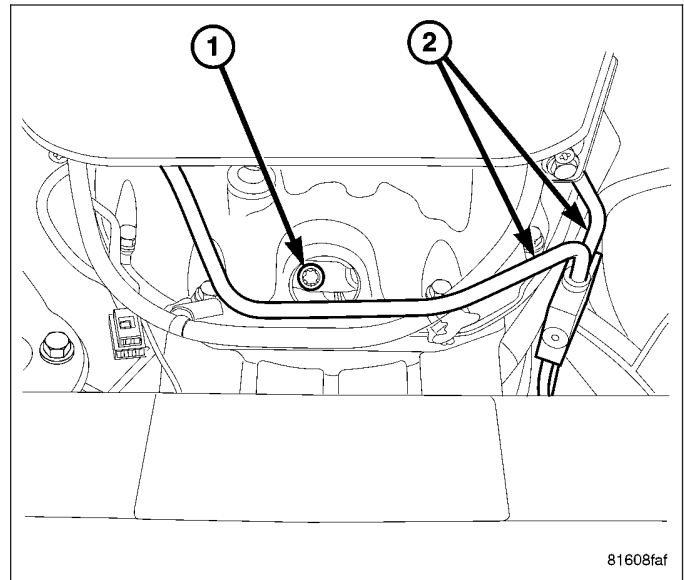
2. Install left engine mount (3) to engine. Tighten bolts to 20 N.m (15 ft. lbs.).



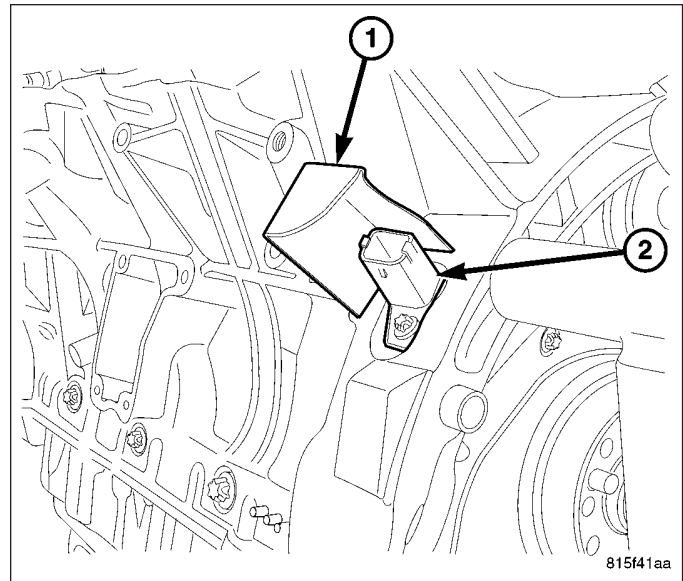
3. Install right engine mount to engine (1). Tighten bolts to 20 N·m (15 ft. lbs.).



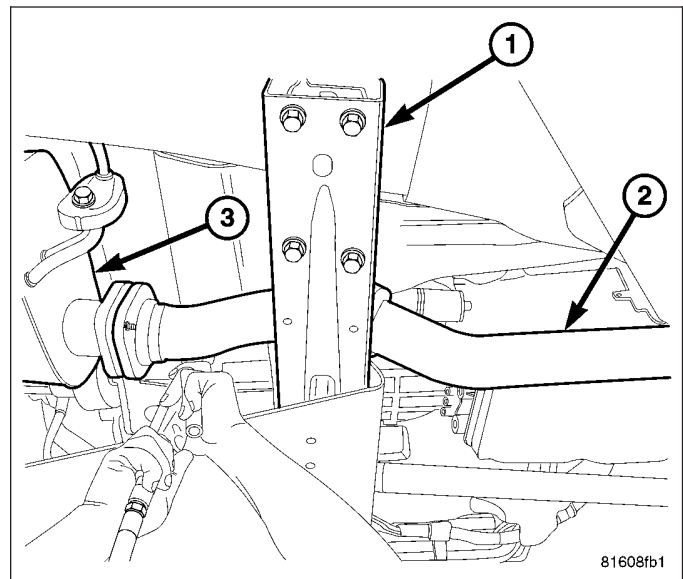
4. Align the engine to transmission, and lower the engine mounts into position.  
5. Remove engine lifting device.  
6. Route the transmission wiring harness through to the rear of the engine.  
7. Raise and support the vehicle.  
8. Install accessible engine to transmission housing bolts. Tighten bolts to 68 N·m (50 ft. lbs.).  
9. Support the transmission and remove the rear transmission crossmember retaining bolts.  
10. Lower the transmission and install the upper transmission to engine fasteners. Tighten bolts to 68 N·m (50 ft. lbs.).  
11. Raise the transmission and install the transmission crossmember.  
12. Install the flex plate to torque converter bolts (1).  
13. Tighten engine mount through bolts to 30 N·m (22 ft. lbs.).  
14. Install the engine ground wire above the starter (1). Tighten bolt to 14 N·m (10 ft. lbs.).  
15. Install the starter wiring.



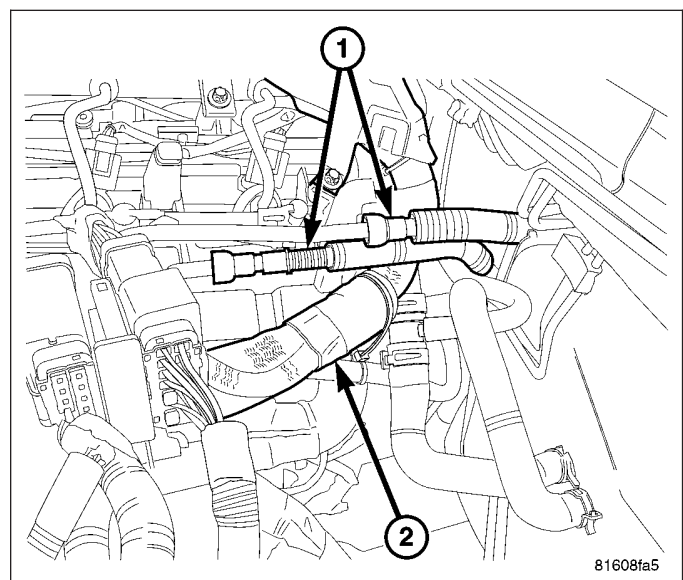
16. Connect the crankshaft sensor (2) wiring harness connector.
17. Route the transmission wiring harness and make necessary sensor connections at the transmission.
18. Install the front axle housing (Refer to 3 - DIFFERENTIAL & DRIVELINE/FRONT AXLE - C200FE - INSTALLATION).



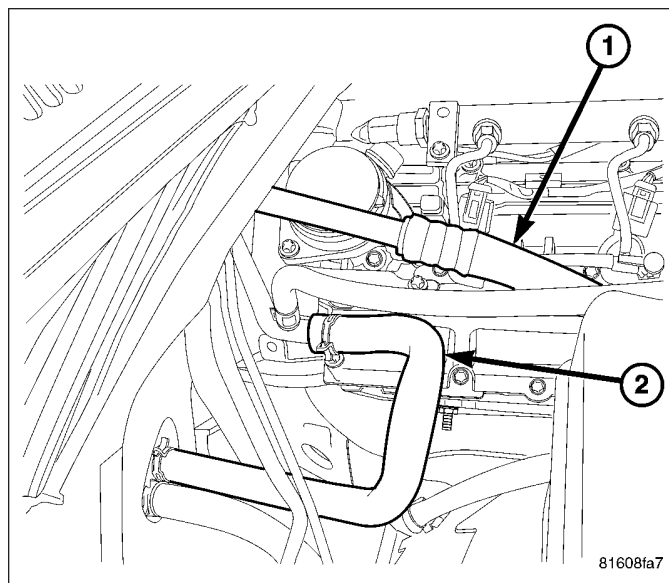
19. Install the catalytic converter and front exhaust pipe (2).
20. Install the transfer case shield.
21. Lower the vehicle.



22. Install the fuel supply and return lines to the fuel pipe.



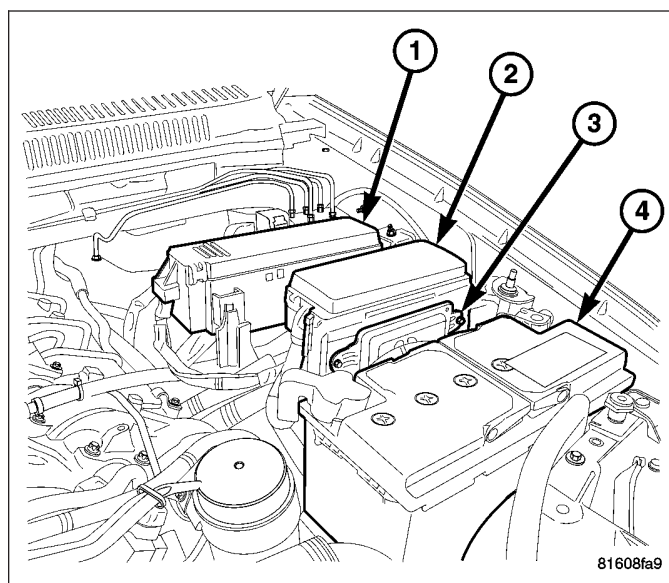
23. Attach the axle vent tube to the wiring harness.
24. Secure the transmission oil level indicator.
25. Install the engine cover bracket.
26. Connect the A/C lines (1) at the expansion valve.
27. Connect the coolant hose, at the outer housing, by the generator.
28. Connect the coolant by-pass hose at the cooler tube (2) on the right cylinder head.
29. Connect the heater hose, at the cooler tube (2) on the right cylinder head.



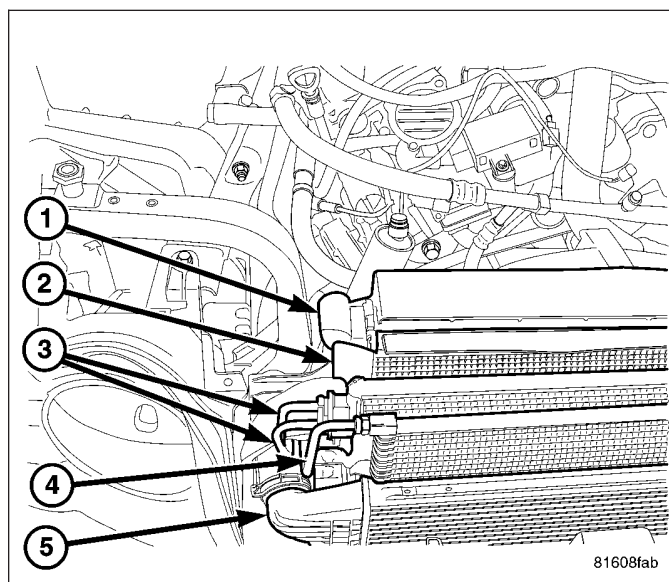
30. Connect the wiring harness connectors to the PDC (1).
31. Connect the vacuum hose to the vacuum pump.
32. Connect the generator wiring.
33. Connect the A/C compressor wiring harness connector.
34. Connect the PCM wiring harness connectors.
35. Install the PDC (1) bracket and mount the PDC (1).

**NOTE: Do Not connect the negative battery cable when installing the battery.**

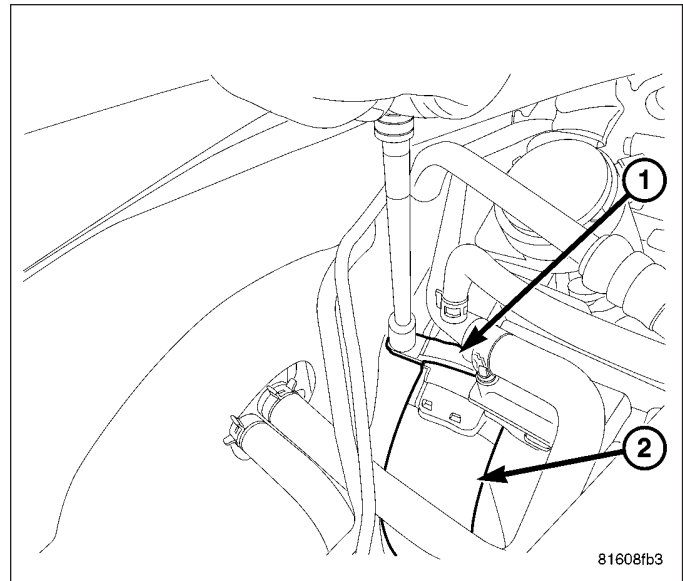
36. Install the battery (4) and tray.



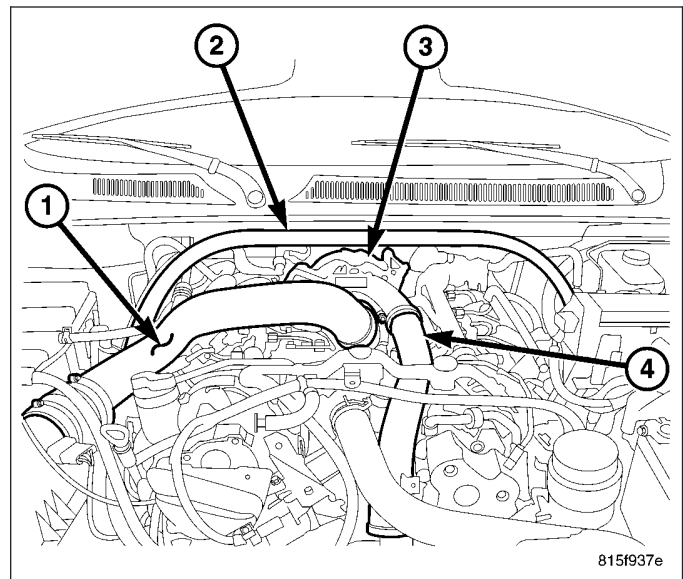
37. Install the coolant module assembly.
38. Connect the transmission cooler (3) and power steering cooler (4) lines to the coolant module.
39. Connect the suction / discharge lines at the A/C condenser and accumulator.
40. Connect the power steering reservoir hose to pump, at the reservoir.
41. Install the charge air inlet and outlet hoses at cooler (5).
42. Install the front core support bracket.
43. Install the front grille and upper radiator core support bracket with the hood latch.
44. Raise and support the vehicle.



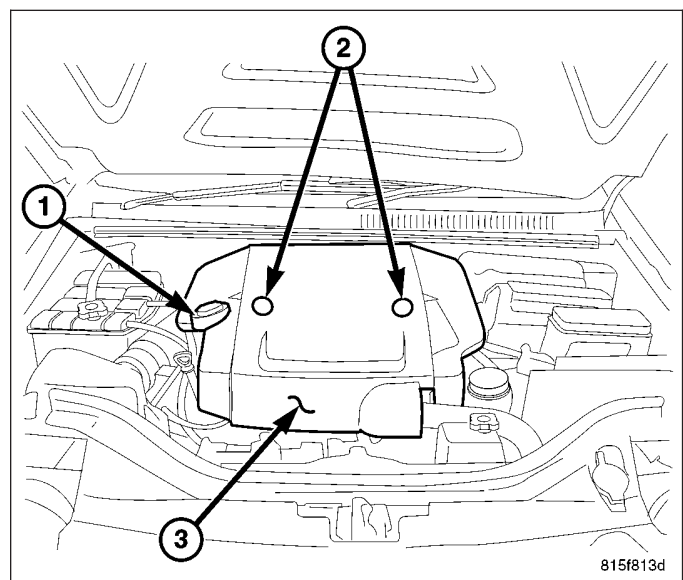
45. Install the power steering hydraulic lines at cooling fan (Refer to 19 - STEERING/PUMP/HOSES - INSTALLATION).
46. Install the lower radiator hose.
47. Lower the vehicle.
48. Install lower catalytic converter exhaust clamp (1) behind right cylinder head.



49. Install the turbocharger (3) upper heat shield.
50. Install air cleaner housing and connect the air cleaner outlet tube (1) to the turbocharger.
51. Install the strut tower support (2).
52. Fill all appropriate fluid levels.
53. Evacuate and recharge air conditioning.
54. Connect the negative battery cable.
55. Start engine, allow to warm, turn engine off and inspect for leaks. (Refer to 14 - FUEL SYSTEM - WARNING).
56. Bleed power steering system using the scan tool procedure.
57. Install lower splash shields.

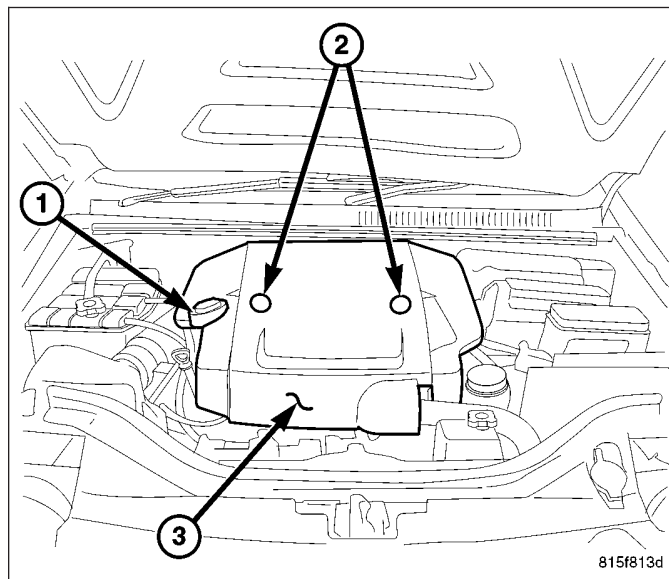


58. Install engine cover (3).



## ENGINE COVER

1. Align the rear of the engine cover (3) with the rear mounting bracket slots and seat the cover into the bracket.
2. Push down on the cover (3) and install the fasteners (2).
3. Tighten fasteners to 5 N·m (44 in. lbs.).
4. Install the oil cap (1).



## SPECIFICATIONS

### ENGINE SPECIFICATIONS

#### GENERAL DESCRIPTION

DESCRIPTION	SPECIFICATION
Displacement 3.0L	3.0L (2985 cc) (182 CID)
Bore	83 mm (3.26 in.)
Stroke	92 mm (3.62)
Compression Ratio	18 :1
Weight	215Kg (474 Lbs.)
Power	160Kw (215 HP) @ 4200 RPM
Torque	510 N·m (376 Ft. Lbs.) @ 1800 RPM
Idle Speed - Warm	620 RPM
Belt Tension	Automatic Belt Tensioner
Thermostat Opening	80°C ± 2°C (176°F ± 36°F)
Cooling System Capacity	13.3 Liters (14 qts.)
Engine Oil Capacity	9.5L (10 Qt.) W/Filter Change
Timing System	Chain Driven Dual Overhead Camshafts
Air Intake	Dry Filter With Turbocharger and Charge Air Cooler
Fuel Supply	Electric Pump In The Fuel Tank
Fuel System	Direct Fuel Injection Common Rail System
Combustion Cycle	4 Stroke
Compression Tolerance Or New Value	27 - 32 bar (392 - 464 psi)
Cylinder Compression Difference Between Cylinders	3 Bar (43.5 psi.)
Cylinder Leaktightness Permissible Total Loss	≤25%
Cylinder Leaktightness Permissible Loss At Valves And Cylinder Head Gasket	≤10%



DESCRIPTION	SPECIFICATION
Cylinder Leaktightness Permissible Loss At Pistons And Piston Rings	≤20%
Cooling System	Water Cooling
Injection Pump	CP3 2nd. Generation Common Rail System
Injection Order	1-4-2-5-3-6
Lubrication	Pressure Lubricated By Rotary Pump
Oil Pressure 80°C (176°F)	1.1 Bar (16 psi.) at Idle 3.6 Bar (52 psi) at 3200 rpm
Engine Rotation	Clockwise Viewed From Front Cover

## CRANKSHAFT

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Crankshaft Main Bearing Cap Bolts		
Thread Diameter	11 mm	.43 in
Length When New	66 mm	2.5985 in.
Maximum Length	67.8 mm	2.6693 in.
Crankshaft Journal Diameter		
Nominal Diameter	75.940 - 75.965 mm	2.98 — 2.99 in.
First Repair Size	75.960 - 75.965 mm	2.9906 — 2.9908 in.
Second Repair Size	75.955 - 75.960 mm	2.9904 — 2.9906 in.
Third Repair Size	75.950 - 75.955 mm	2.9902 — 2.9904 in.
Fourth Repair Size	75.945 - 75.950 mm	2.99 — 2.9902 in.
Fifth Repair Size	75.940 - 75.945 mm	2.9898 — 2.99 in.
Crankshaft Journal Width At Fit Bearing		
Identification Colorless/0	29.500 - 29.533 mm	1.16 — 1.163 in.
Red/1	29.600 - 29.633 mm	1.164 — 1.166 in.
Standard Dimension For Main Bearing Shells In Crankcase Upper And Lower Sections - Diameter 70.00 Mm (2.755 in.)		
Bearing shell thickness (Replacement part additional number (color coding blue) - 52)	2.250 - 2.255 mm	0.0886 — 0.0876 in.
Bearing shell thickness (Replacement part additional number (color coding yellow) - 54)	2.255 - 2.260 mm	0.0876 — 0.089 in.
Bearing shell thickness (Replacement part additional number (color coding red) - 56)	2.260 - 2.265 mm	0.089 — 0.0892 in.
Bearing shell thickness (Replacement part additional number (color coding white) - 57)	2.265 - 2.270 mm	0.089 — 0.0894 in.
Bearing shell thickness (Replacement part additional number (color coding purple) - 58)	2.270 - 2.275 mm	0.0894 — 0.0896 in.
Crankshaft Bearing Clearance (When New)	0.029 - 0.056 mm	0.0012 — 0.0023 in.
Axial play of crankshaft	0.100 - 0.254 mm	0.004 — 0.01 in.



**CYLINDER HEAD**

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Height Of Cylinder Head Without Camshaft Housing		
When new	128.35 - 128.65 mm	5.0532 — 5.065 in.
Wear limit after machining	NA	NA
Valve Setback With New Valves And New Valve Seat Rings		
Exhaust valve	0.7 - 1.1 mm	0.0276 — 0.0434 in.
Intake valve	1.0 - 1.4 mm	0.0394 — 0.0552 in.
Flatness Of The Separating Surface Of The Cylinder Head	0.05 mm	.002 in.
Cylinder Head Bolts		
Thread Diameter	12 mm	NA
Length When New	205 mm	8.0709 in.
Maximum Length	207 mm	8.1496 in.

**VIBRATION DAMPER**

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Permissible Difference At Vibration Damper		
Radial runout	0.4 mm	0.158 in.
Axial runout	0.4 mm	0.158 in.

**CYLINDER BORE**

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Cylinder Liner Diameter		
Standard dimensions	83.009 mm	3.268 in.
Group code letter A	83.000 - 83.006 mm	3.2678 — 3.268 in.
Group code letter X	83.006 - 83.012 mm	3.268 — 3.2682 in.
Group code letter B	83.012 - 83.018 mm	3.2682 — 3.2685 in.
1st repair size	83.050 mm	3.2697 in.
2nd repair size	83.100 mm	3.272 in.
Cylinder Liner		
Wear limit in longitudinal and transverse direction	0.20 mm	0.0079 in.
Permissible difference for cylinder shape (when new)	0.000 - 0.007 mm	0.000 — .0003 in.
Wear limit	0.05 mm	0.0002 in.
Permissible difference for rectangularity related to cylinder height	0.05 mm	0.0002 in.

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Basic peak-to-valley height (R3Z)	0.002 - 0.005 mm	0.0001 – 0.0002 in.
Maximum peak-to-valley height (Rmax)	0.011 mm	0.0005 in.
Honing angle	40 - 60°	40 - 60°

**CRANKCASE**

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Crankshaft Bearing		
Basic bore diameter	80.000 - 80.522 mm	3.1496 — 3.1702 in.
1st stage blue (Code number 52)	80.500 - 80.507 mm	3.1693 — 3.1696 in.
2nd stage yellow (Code number 54)	80.507 - 80.514 mm	3.1696 — 3.1699 in.
3rd stage red (Code number 56)	80.514 - 80.522 mm	3.1699 — 3.1702 in.
Basic Bore Width At Fit Bearing	24.979 - 25.000 mm	0.9835 — 0.9843 in.
Permissible Out-Of-Roundness And Conicity Of Basic Bore	0.02 mm	0.0008 in.
Crankcase		
Peak-to-valley height (Rz) top contact surface	0.015 - 0.025 mm	0.0006 — 0.001 in.
Waviness (Wt) of top contact surface	0.001 - 0.007 mm	0.0001 — 0.0003 in
Unevenness of contact surface in longitudinal direction	0.03 mm	0.0012 in.
Unevenness of contact surface in transverse direction	0.03 mm	0.0012 in.
Variation of parallelism of top contact surface to bottom in longitudinal direction	NA	NA

**CAMSHAFT**

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Cylinder Head On Right Valve Timing At 2 mm Valve Lift And A New Timing Chain		
Inlet valve opens after TDC	19.6°	19.6°
Inlet valve closes after BDC	5.6°	5.6°
Outlet valve opens after TDC	17.9°	17.9°
Outlet valve closes after BDC	27.9°	27.9°
Cylinder Head On Right Valve Timing At 2 mm Valve Lift And Used Timing Chain		
Inlet valve opens after TDC	21.5°	21.5°
Inlet valve closes after BDC	3.7°	3.7°
Outlet valve opens after TDC	16.0°	16.0°

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Outlet valve closes after BDC	26.0°	26.0°
Cylinder Head On Left Valve Timing At 2 mm Valve Lift And A New Timing Chain		
Inlet valve opens after TDC	20.7°	20.7°
Inlet valve closes after BDC	4.5°	4.5°
Outlet valve opens after TDC	16.8°	16.8°
Outlet valve closes after BDC	26.8°	26.8°
Cylinder Head On Left Valve Timing At 2 mm Valve Lift And Used Timing Chain		
Inlet valve opens after TDC	21.5°	21.5°
Inlet valve closes after BDC	3.7°	3.7°
Outlet valve opens after TDC	16.0°	16.0°
Outlet valve closes after BDC	26.0°	26.0°

## VALVES

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Valve Disk Diameter		
Exhaust	25.3 - 25.5 mm	0.9961 — 1.004 in.
Intake	28.4 - 28.6 mm	1.1182 — 1.126 in.
Height Of Valve Disk		
Exhaust	1.4 - 1.6 mm	0.0552 — 0.063 in.
Intake	1.3 - 1.5 mm	0.0512 — 0.0591
Valve Seat Face Angle		
Exhaust	45° (+ 0.5°)	45° (+ 0.5°)
Intake	45° (+ 0.5°)	45° (+ 0.5°)
Valve Seat Back-cut Angle		
Exhaust	30° (±15')	30° (±15')
Intake	30° (±15')	30° (±15')
Valve Stem Diameter		
Exhaust	5.945 - 5.975 mm	0.2341 — 0.2353 in.
Intake	5.960 - 5.975 mm	0.2347 — 0.2353 in.
Length Of Valve		
Exhaust	102.1 - 102.5 mm	4.0197 — 4.0355 in.
Intake	102.1 - 102.5 mm	4.0197 — 4.0355 in.

**PISTONS**

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Piston Projection With New Crankcase	0.53 - 0.77 mm	
Piston projection (a) with machined crankcase	NA	NA
Piston Diameter		
Piston group A	82.833 - 82.839 mm	3.2612 — 3.2614 in.
Piston group X	82.838 - 82.846 mm	3.2614 — 3.2617 in.
Piston group B	82.845 - 82.851 mm	3.2617 — 3.2619 in.
1st repair size (Piston group +5)	82.876 - 82.890 mm	3.2629 — 3.2634 in.
2nd repair size (Piston group +10)	82.926 - 82.940 mm	3.2648 — 3.2654 in.

**PISTON RINGS**

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Piston Ring End Clearance		
Groove 1	0.12 - 0.16 mm	0.0048 — 0.0063 in.
Groove 2	0.065 - 0.110 mm	0.0026 — 0.0044 in.
Groove 3	0.03 - 0.07 mm	0.0012 — 0.0028 in.
Piston Ring End Gap		
Groove 1	0.12 - 0.16 mm	0.0048 — 0.0063
Groove 2	0.065 - 0.110 mm	0.0026 — 0.0044
Groove 3	0.03 - 0.07 mm	0.0012 — 0.0028
Dimensions Of The Piston Rings		
Keystone ring	NA	NA
Taper-faced ring	NA	NA
Bevel-edged ring	NA	NA
Piston Ring Height		
Bevel-edged ring (DSF-ring)	83 X 2.0 X 3.4 mm	3.2678 X 0.0788 X 0.1339 in.
Taper-faced ring (M-ring)	83 X 2.0 X 3.45 mm	3.2678 x 0.0788 x 0.1359 in.
Double sided half-keystone ring (DT-ring)	83 X 2.0 X 3.4 mm	3.2678 X 0.0788 X 0.1339 in.

**CONNECTING RODS**

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Connecting Rod Bolt		
Thread diameter	8 mm	0.315 in.
Shank length when new	47 mm	1.8504 in.
Maximum shank length	48 mm	1.8898 in.
Distance From Center Of Connecting Rod Bearing Bore To Connecting Rod Bushing Bore	167.97 - 168.03 mm	6.613 — 6.6154 in.
Width Of Connecting Rod At Connecting Rod Bearing Bore	17.90 - 18.10 mm	0.7048 — 0.7126 in.
Width Of Connecting Rod At Connecting Rod Bushing Bore	21.94 - 22.00 mm	0.8638 — 0.8662 in.
Connecting Rod Bushing Inner	30.038 - 30.044 mm	1.1826 — 1.1829 in.
Connecting Rod Bushing Outer Diameter	32.500 - 32.525 mm	1.2796 — 1.2806 in.
Piston Pin Play In Connecting Rod Bushing	0.028 - 0.034 mm	0.0012 — 0.0014 in.
Peak-To-Valley Height (Rz) Of Connecting Rod Bushing On Inside	5 mm	0.1969 in.
Connecting Rod Bearing Shell Basic Bore	67.600 - 67.614 mm	2.6615 — 2.662 in.
Permissible Out-Of-Roundness And Concentricity Of Basic Bore	0.020 mm	0.0008 in.
Permissible Twist Of Connecting Rod Bearing Bore To Connecting Rod Bush Bore Over A Length Of 100 mm	0.1 mm	0.004 in.
Permissible Variation Of Axial Parallelism Of Connecting rod Bearing Bore To Connecting rod Bushing Bore Over A Length Of 100 mm	0.045 mm	0.0018 in.
Permissible Difference In Weight Of Complete Connecting Rod Of An Engine	2 grams	0.07 oz.

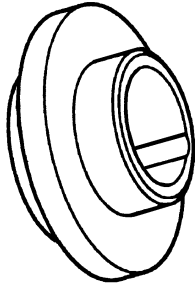
**TORQUE****3.0L DIESEL TORQUE SPECIFICATIONS**

DESCRIPTION	N-m	Ft. Lbs.	In. Lbs.
Bolts, Oil Pump	11	8	96
Bolts, Vacuum Pump	14	10	124
Vacuum Pump Pipe to Block	57	42	-
Bolts, Crankshaft Gear	11	8	96
Bolts, Crankshaft Position Sensor	11	8	96
Flex Plate Bolts - Refer to the Service Procedure			
Cylinder Head Bolts - Refer to the Service Procedure			
Bolts, Reluctor Wheel	15	11	130
Bolts, Rear Main Bearing Support	28	21	240
Bolt, Oil Cooler to Engine Block	47	35	-
Engine Block Plug In Front Of Oil Cooler	58	43	-
Stud, Oil Cooler Mounting	50	37	-
Bolt, Oil Level Indicator to Cylinder Head Cover	11	-	96
Bolt, Oil Level Indicator Tube to Pan	11	-	96
Fasteners, Water Pump Housing	24	18	212
Bolts, Connecting Rod - Refer to the Service Procedure			
Bolts, Balance Shaft	32	24	-
Bolts, Oil Jet	11	8	96
Bolt, Oil Pump Pick-up Tube	32	24	-
Bolts, Oil Pan — Refer to the Service Procedure			
Structural Support to Engine and Transmission Bolts	45	33	-
Bolt, Crankshaft Hub	303+90°	224+90°	-
Bolts, Crankshaft Pulley	32	24	-
Bolts, Front Engine Cover	9	7	-
Bolts, Transmission to Engine	83	62	-
Bolts, Cylinder Head Cover / Intake Manifold — Refer to the Service Procedure			
Bolts, Camshaft Timing Access	25	18	-
Camshaft Access Plugs	80	59	-
Bolts, Oil Separator	11	8	96
Bolt, Camshaft Position Sensor	11	8	96
Bolts, Boost Pressure / Intake Air Temperature. Sensor	5	-	48
Glow Plug	13	-	110
Bolts, Accessory Drive Bracket	45	33	-
Bolt, Accessory Drive Belt Idler Pulley	53	39	-
Bolt, Vacuum Line Fitting	57	42	-
Fasteners, Fuel Pump	28	21	-
Fittings, Fuel Line at Pump	28	21	-
Bolts, Fuel Rail Retaining	25	18	217

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Bolts, Inner Timing Belt Cover			
8mm	11	8	96
10mm	45	33	-
Bolts, Outer Timing Belt Cover			
3mm	6	-	54
8mm	11	8	96
Bolts, Engine Mount Bracket to Cylinder Head	45	33	-
Bolts, Structural Support to Engine and Transmission	45	33	-
Bolts, Intake Inlet Tube	10	8	89
Bolts, Camshaft Sprocket	108	80	-
Bolts, Camshaft Timing Access	25	18	212
Bolt, Timing Belt Idler Pulley	47	35	-
Bolt, Timing Belt Tensioner	29	22	-
Nut, Fuel Injection Pump Gear	88	65	-
Nuts, Fuel Injection Pump Retaining	24	18	212
Bolts, Engine Lift Hook	45	33	-
Bolts, Thermostat Housing	25	18	-
Fitting, Turbocharger Oil Supply Line	25	18	217
Bolts, Turbocharger Oil Return Line	11	-	96
Nuts, Engine Cover	5	-	44
Nuts, Exhaust Manifold	36	27	-
Bolts, Turbocharger Heat Shield	25	18	217
Bolts, Exhaust Manifold Heat shield	28	21	-
Bolts, EGR Valve	25	18	-
EGR Air Control Valve to Cylinder Head Cover	11	-	96
Bolts, Coolant Pipe to EGR Valve	25	18	-
Nuts, Turbocharger Down pipe	32	24	-
Bolts, Turbocharger Support Bracket	25	18	-
Bolts, Vibration Damper to Crankshaft Hub	28	21	-
Bolts, Crankshaft Support	44	33	-
Nuts, Turbocharger to Exhaust Manifold	32	24	-

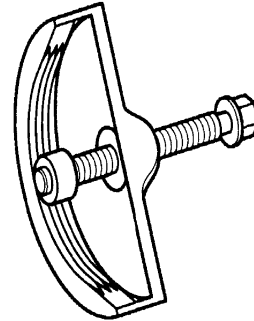


## SPECIAL TOOLS - 3.0L TURBODIESEL



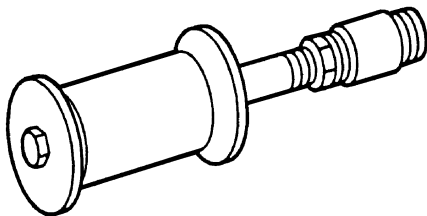
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**INSTALLER, FRONT CRANKSHAFT SEAL - 8936A**



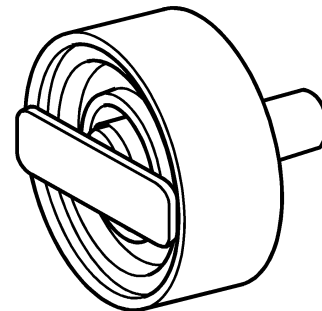
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**REMOVER, VIBRATION DAMPER - 8940**



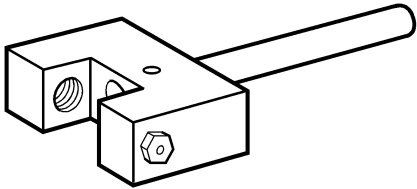
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**HAMMER, SLIDE - 8937**



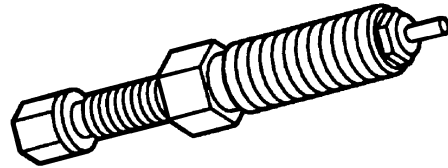
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**INSTALLER, REAR MAIN SEAL - 8944**



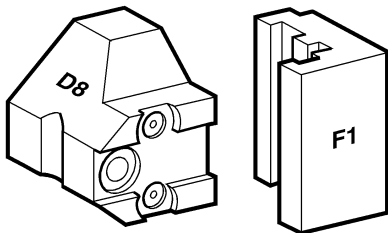
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**TOOL, CHAIN SEPARATOR - 8948**



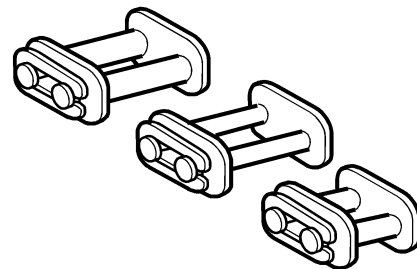
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**SCREW, PRESSING - 8950**



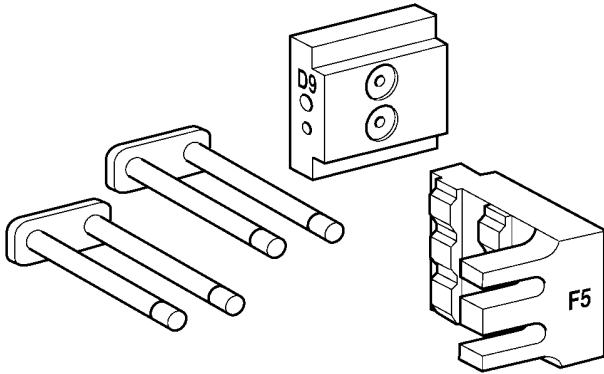
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**PIECE, THRUST - 8949A**



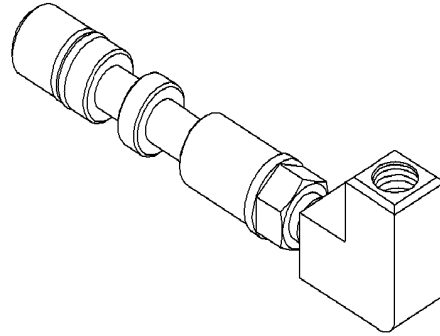
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**LINKS, ASSEMBLY - 8951**

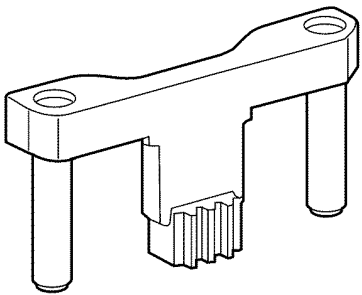


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**INSERTS, ASSEMBLY - 8952A**

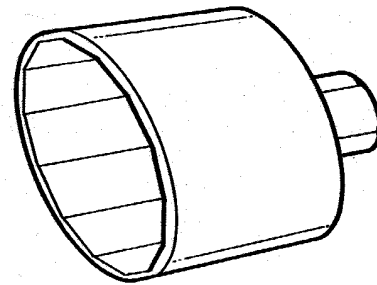


**ADAPTOR - 9543**

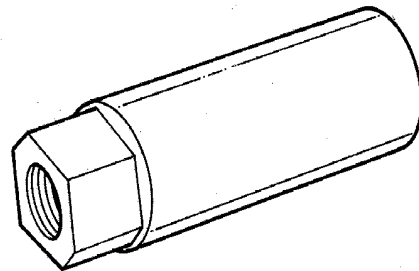


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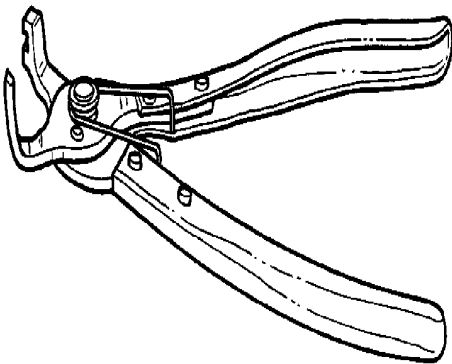
**TOOL, FLYWHEEL LOCKING - 9102**



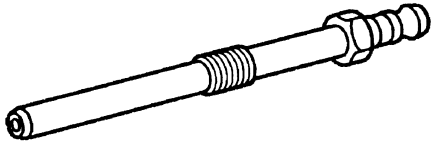
**Wrench, Oil Filter Cap - 9551**



**Remover, Fuel Injector - 9552**

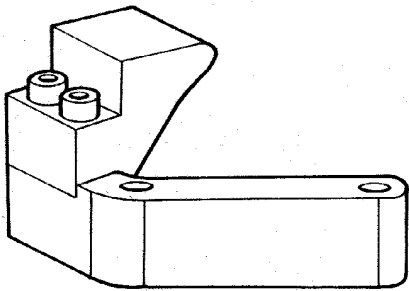


**PLIERS, FUEL LINE - 9539**

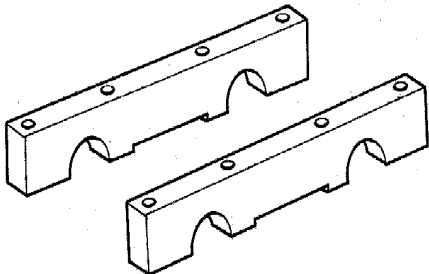


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**ADAPTER, COMPRESSION TESTER - 9553**



**GUIDE, TIMING CHAIN - 9554**



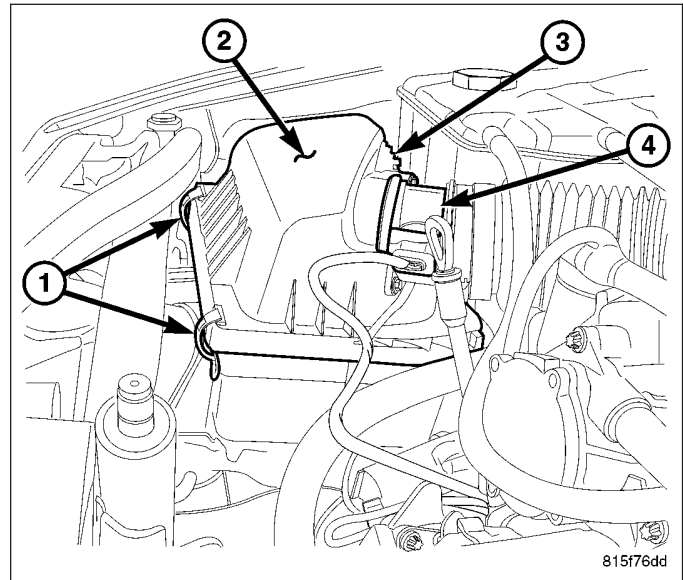
**Retainer, Camshafts - 9555**

## ELEMENT-AIR CLEANER

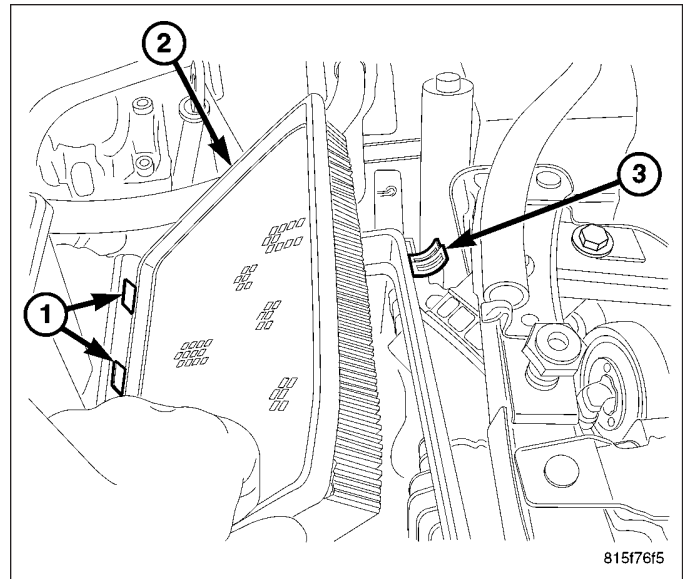
### REMOVAL

**NOTE:** Housing removal is not necessary for element (filter) replacement.

1. Disconnect the negative battery cable.
2. Disconnect the mass air flow (MAF) (4) and air pressure sensor (3) electrical connectors.
3. Pry up 2 spring clips (1) from front of housing cover (2), (spring clips retain cover to housing).
4. Release housing cover (2) from locating tabs located on rear of housing, and lift cover.



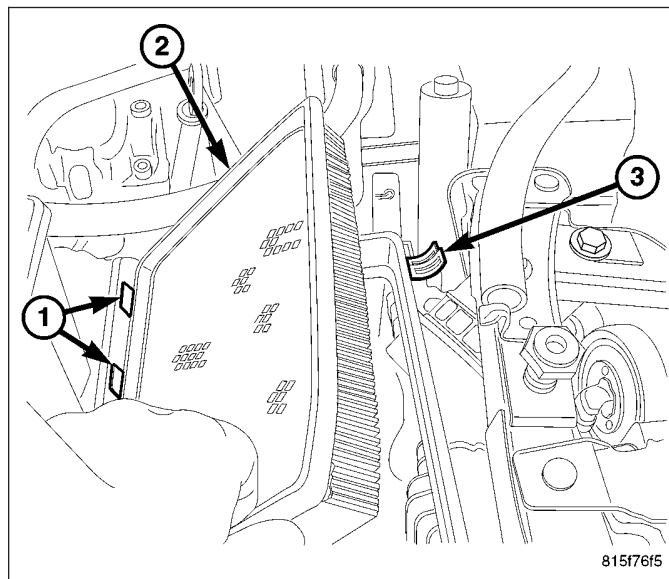
5. Remove air cleaner element (2) from housing.



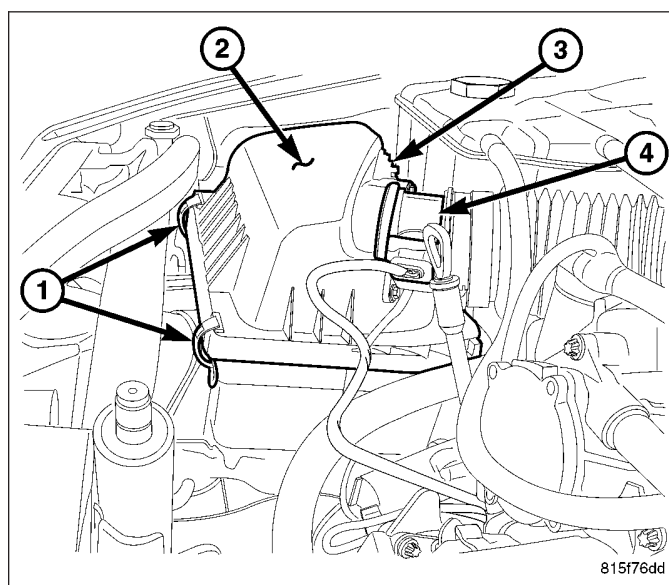
## INSTALLATION

**NOTE:** Clean housing and inspect the gasket for damage before installing a clean filter. Replace as necessary.

1. Install element into housing (2).
2. Position housing cover into rear housing locating tabs (1) and seat cover onto housing.



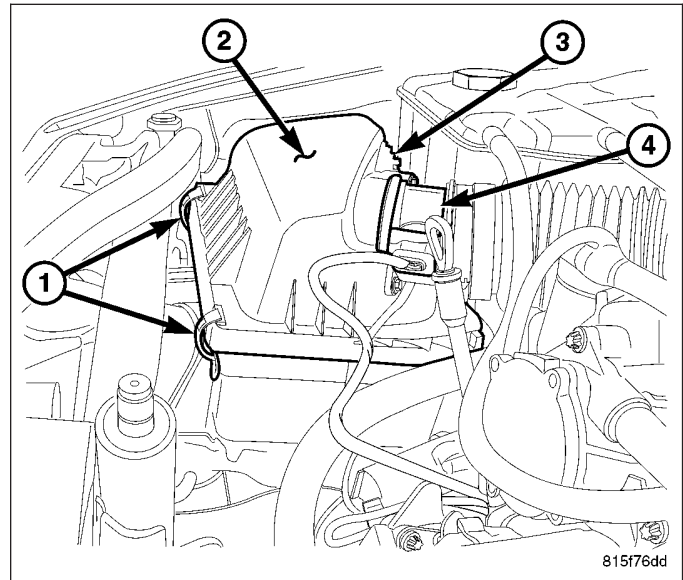
3. Pry up spring clips (1) and lock cover to housing.
4. Connect air intake duct and tighten clamp to 5 N.m (44 in. lbs.).
5. Connect the MAF (4) and air pressure sensor (3) electrical connectors.
6. Connect the negative battery cable.



## HOUSING-AIR CLEANER

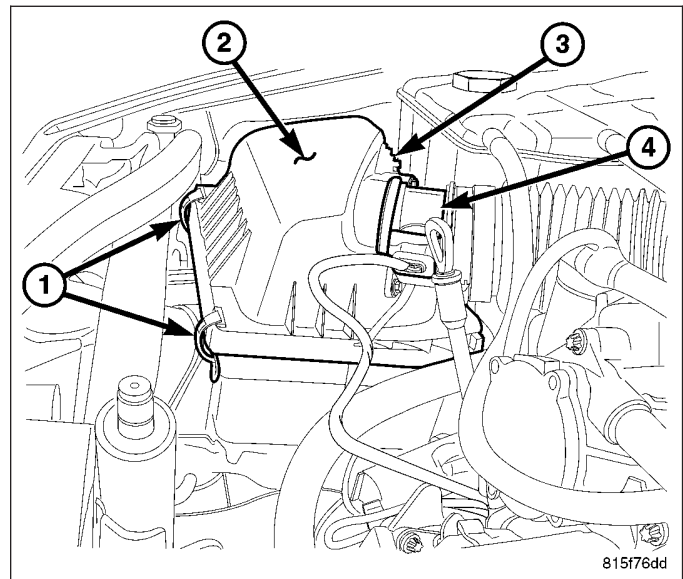
### REMOVAL

1. Disconnect the negative battery cable.
2. Disconnect the MAF (4) and air pressure sensor (3) electrical connectors.
3. Remove the air outlet hose from the air cleaner assembly.
4. Pry up two spring clips (1) from front of housing cover (2) (spring clips retain cover to housing).
5. Release housing cover (2) from locating tabs located on rear of housing, and remove cover (2).
6. Remove the rear lower housing to fender well fastener.
7. Remove the air inlet duct.
8. Pulling upward, remove the air cleaner housing.



### INSTALLATION

1. Position the lower housing and attach the air inlet duct.
2. Install the lower housing to fender well fastener. Tighten fastener to 5 N·m (44 in. lbs.).
3. Install the air cleaner element.
4. Position housing cover (2) into housing locating tabs.
5. Pry up spring clips (1) and lock cover (2) to housing.
6. Install the air outlet tube. tighten clamp to 5 N·m (44 in. lbs.).
7. Connect the MAF (4) and air pressure sensor (3) wire harness connectors.
8. Connect the negative battery cable.

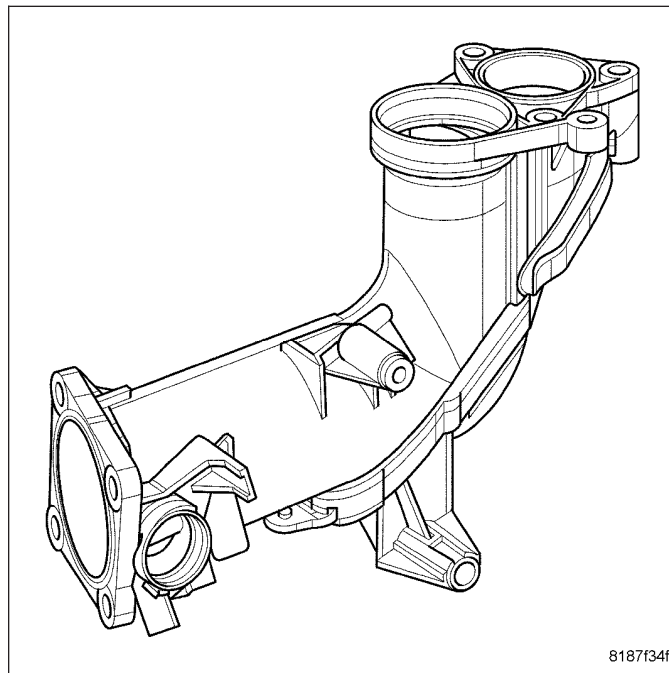




## CHAMBER-MIXING

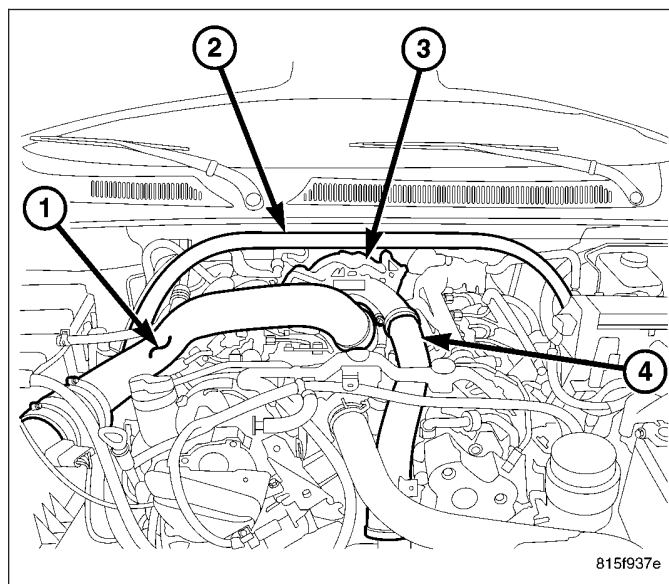
### DESCRIPTION

The mixing chamber is made of plastic material and is located between the EGR throttle valve and the intake manifolds. The mixing chamber mixes the flow of fresh air from the EGR throttle valve with exhaust gases coming from the EGR cooler. The mixed air is distributed to the left-bank and right-bank intake manifolds.

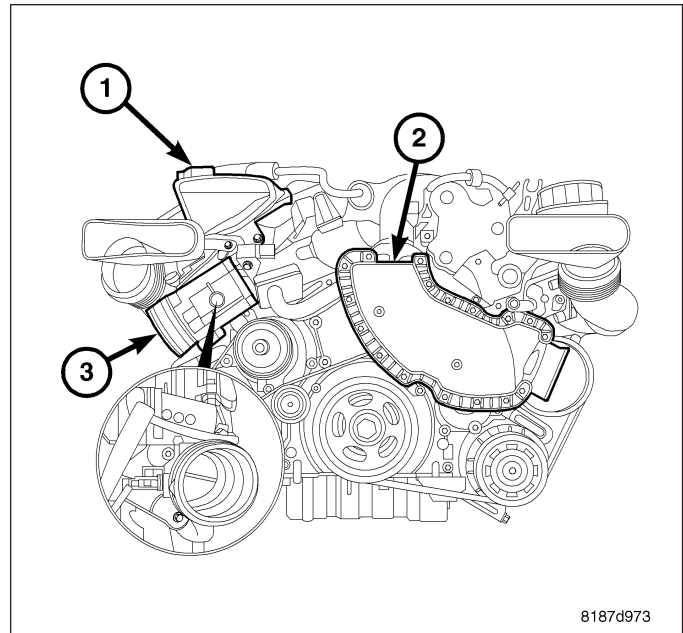


### REMOVAL

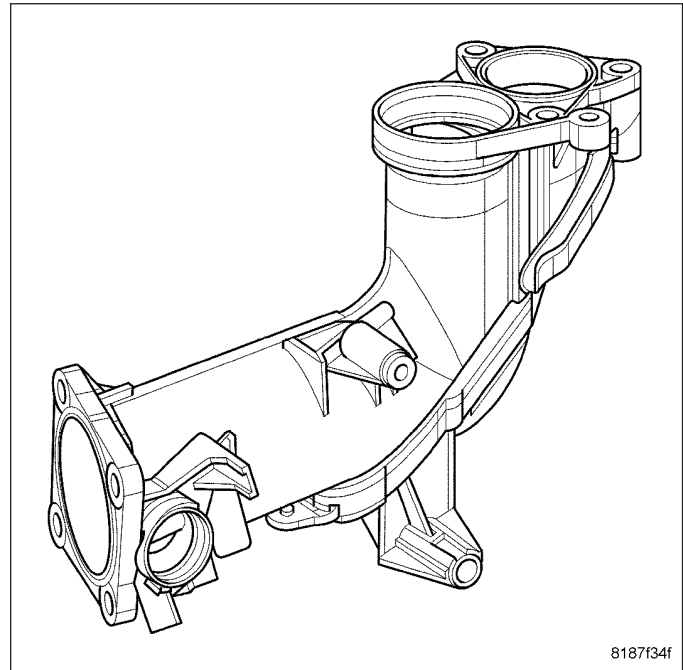
1. Remove the charge air inlet tube (4).
2. Disconnect the EGR temperature sensor.
3. Disconnect the glow plug control module connector.
4. Disconnect the IAT sensor.
5. Disconnect the EGR Valve Actuator.



6. Remove the resonator.

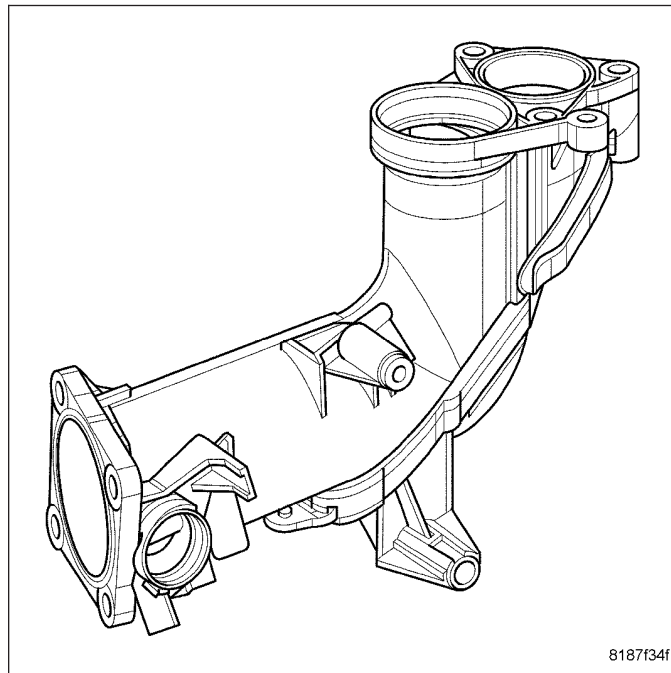


7. Remove the mixing chamber.

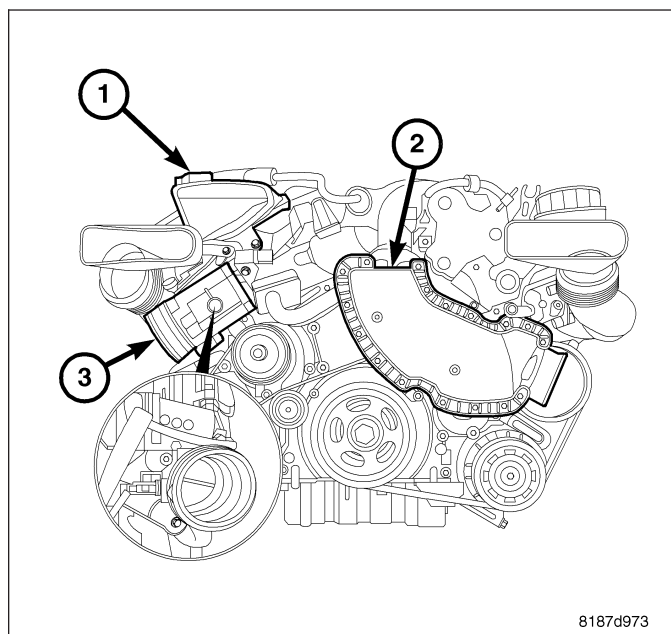


## INSTALLATION

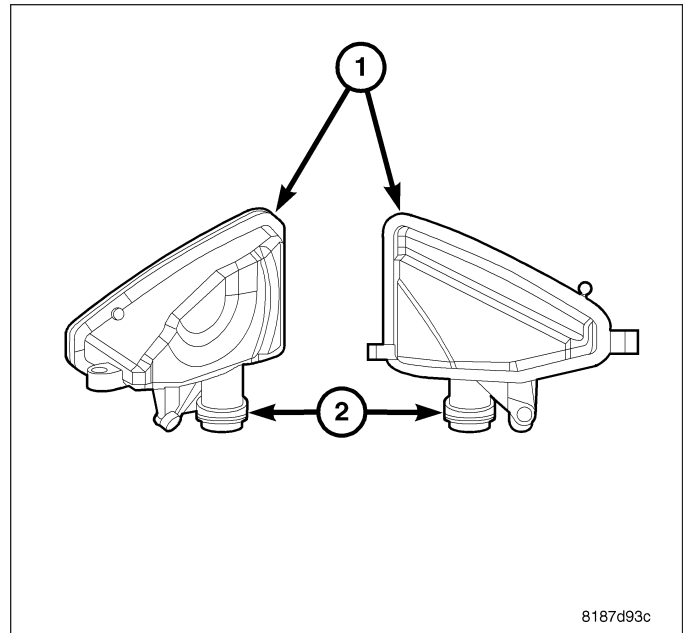
1. Install the mixing chamber. Tighten bolt to 9 N·m (80 in. lbs.).



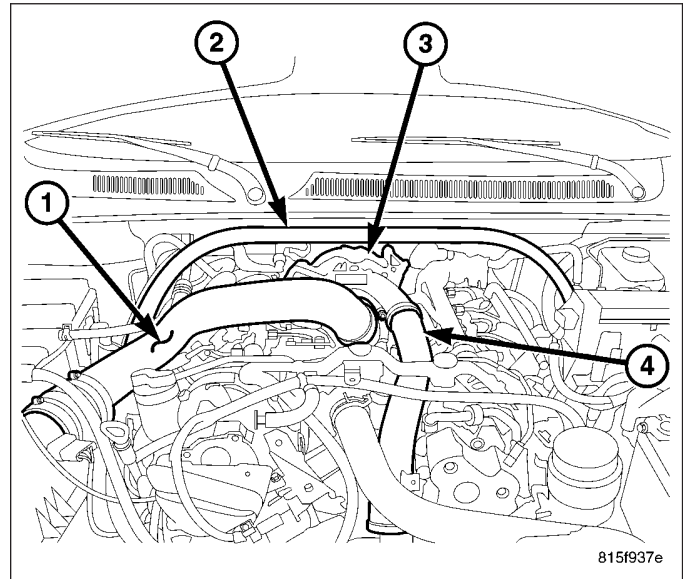
2. Reconnect the EGR temperature sensor.
3. Reconnect the glow plug control module connector.
4. Reconnect the IAT sensor.
5. Reconnect the EGR Valve Actuator.



6. Install the resonator. Tighten bolt to 9 N·m (80 in. lbs.)



7. Install the charge air inlet tube (4).



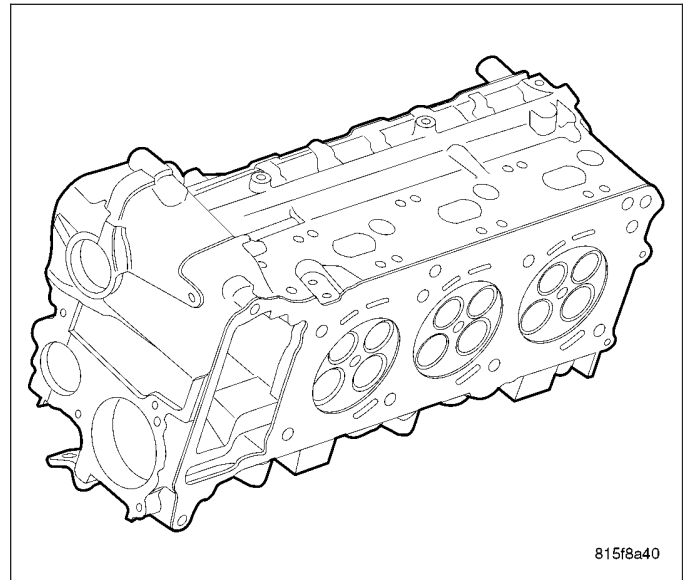
## HEAD-CYLINDER

### DESCRIPTION

The cylinder heads on the 3.0L V-6 Diesel Engine must withstand high thermal and mechanical loads due to the high specific output and combustion peak pressures of up to 175 bar (2,540 psi). The cylinder heads are of a cross-flow design and have the following features:

- High-Strength Cast Aluminum Alloy Construction.
- Four Valves per Cylinder.
- Roller Finger Followers/Lifter Assemblies.
- Pressed-in Valve Guides and Valve Seats.

The 3.0L aluminum, overhead valve cylinder heads are made of high strength aluminum alloy and are each equipped with two camshafts, roller finger followers/lifter assemblies and four valve technology. The cylinder head itself is not resurfacing. The cylinder head uses a Multi-layered Steel gasket for sealing.



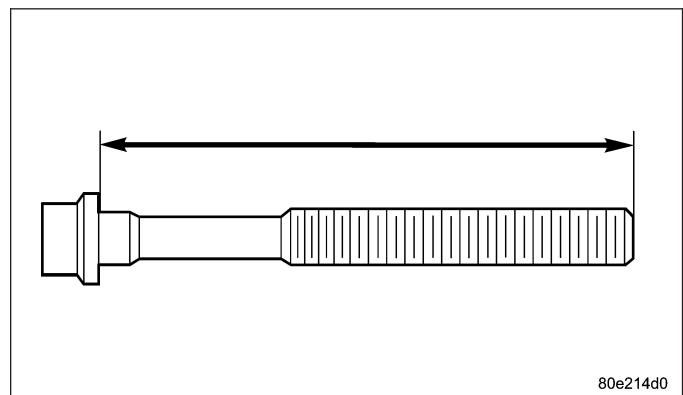
### STANDARD PROCEDURE

#### CYLINDER HEAD BOLT INSPECTION

1. Measure cylinder head bolts between points shown.

Cylinder Head Bolts	Thread Diameter	12 mm
	Length When New	205 mm
	Maximum Length	207 mm

2. If the cylinder head bolt length is greater than the maximum allowable measurement, replace the cylinder head bolts.



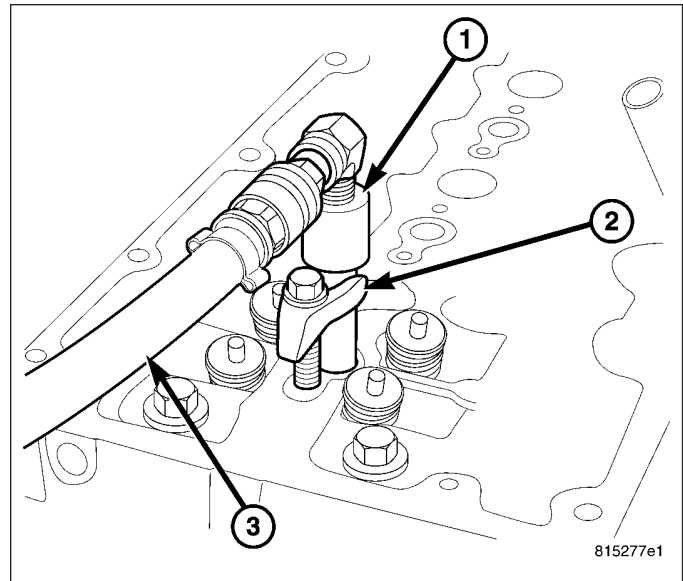
### VALVE SEALS - IN VEHICLE

1. Disconnect the negative battery cable.
2. Remove the intake manifold/cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

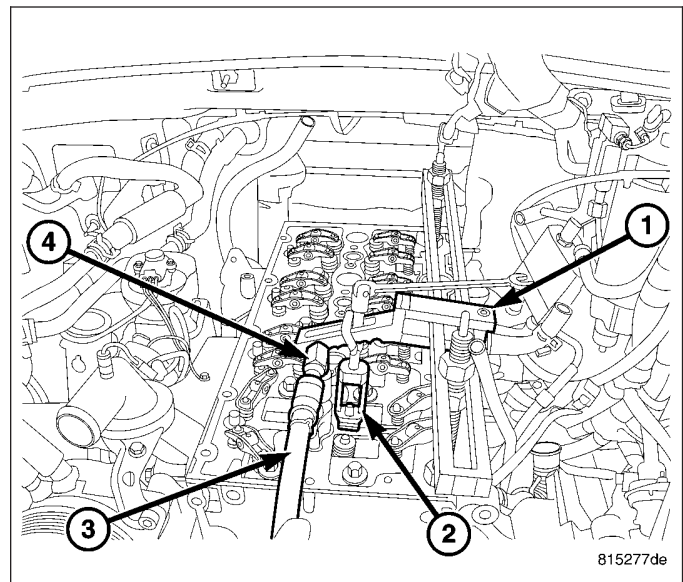
**NOTE:** Rocker arms and lifters must be kept in order of removal and stored in the up right position.

3. Position the rocker arms aside. (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - REMOVAL).

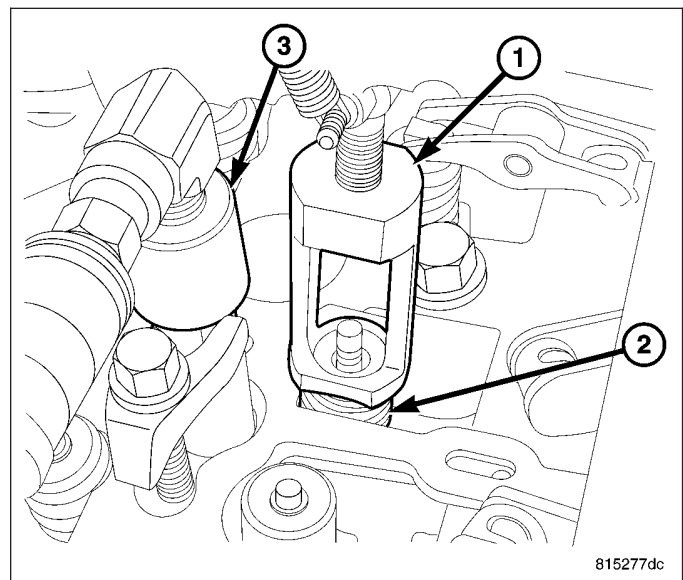
4. Install special tool VM.1072A, compression tester adaptor, into the injector hole and retain with an injector hold down bolt.



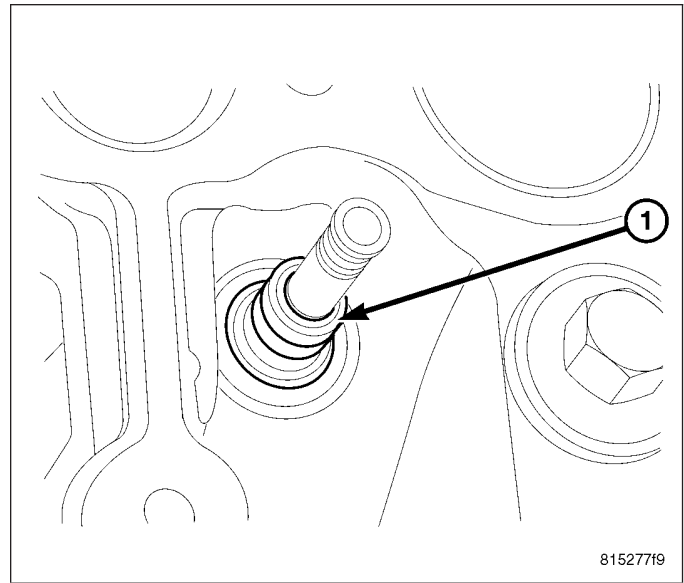
5. Prepare special tool MD998772A for usage by inverting the tool to cylinder head holding screws so that the thread size matches the cylinder head.
6. Install special tool MD998772A onto cylinder head and using adaptor MD998772A-15, place the adaptor over the valve spring.
7. Connect a regulated shop air supply to VM.1072A, and pressurize the cylinder.
8. Place shop towels around the working area of the cylinder head to prevent valve locks from accidentally entering the engine.



9. Using adaptor MD998772A-15 adaptor, collapse the valve spring and remove the locks.
10. Remove the valve spring assembly.



11. Remove the valve seal.
12. Repeat this procedure for all cylinders.



## VALVE SERVICE

This procedure is done with the engine cylinder head removed from the block.

### DISASSEMBLY

1. Remove the engine cylinder head from the cylinder block (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).
2. Use Valve Spring Compressor Tool and compress each valve spring.
3. Remove the valve locks, retainers, and springs.
4. Use a smooth stone or a jewelers file to remove any burrs on the top of the valve stem, especially around the groove for the locks.
5. Remove the valves, and place them in a rack in the same order as removed.

### VALVE CLEANING

1. Clean all carbon deposits from the combustion chambers, valve ports, valve stems, valve stem guides and head.
2. Clean all residue and gasket material from the engine cylinder head machined gasket surface.

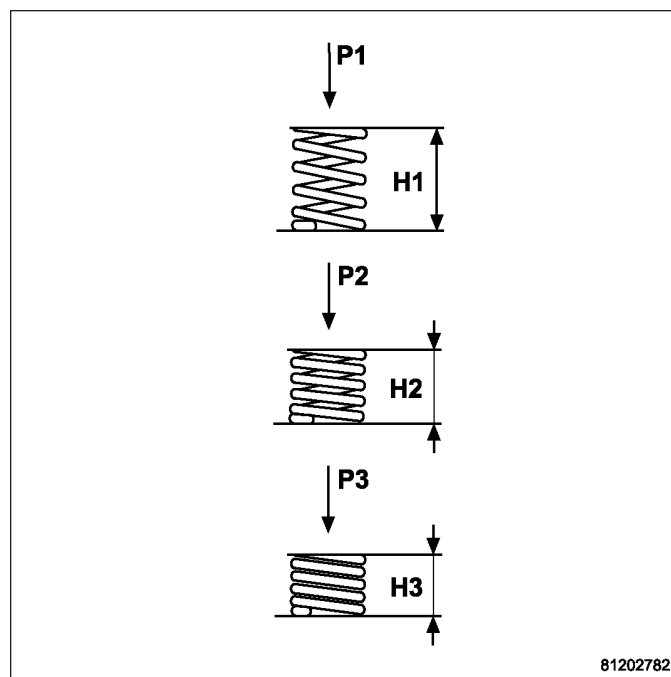
### INSPECTION

1. Inspect for cracks in the combustion chambers and valve ports.
2. Inspect for cracks on the exhaust seat.
3. Inspect for cracks in the gasket surface at each coolant passage.
4. Inspect valves for burned, cracked or warped heads.
5. Inspect for scuffed or bent valve stems.
6. Replace valves displaying any damage.
7. Check valve spring height.



## VALVE SEAT REFACING

1. Install a pilot of the correct size in the valve guide bore. Reface the valve seat to the specified angle with a good dressing stone. Remove only enough metal to provide a smooth finish.
2. Use tapered stones to obtain the specified seat width when required.

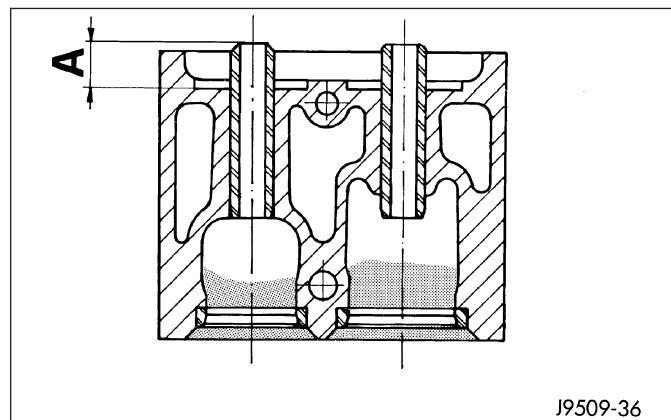


## VALVE GUIDES

1. Valve Guides height requirement.
2. Measurement A : 16.50 - 17.00 mm. Measurement B : 14.50 - 15.00 mm.

## VALVE STEM-TO-GUIDE CLEARANCE MEASUREMENT

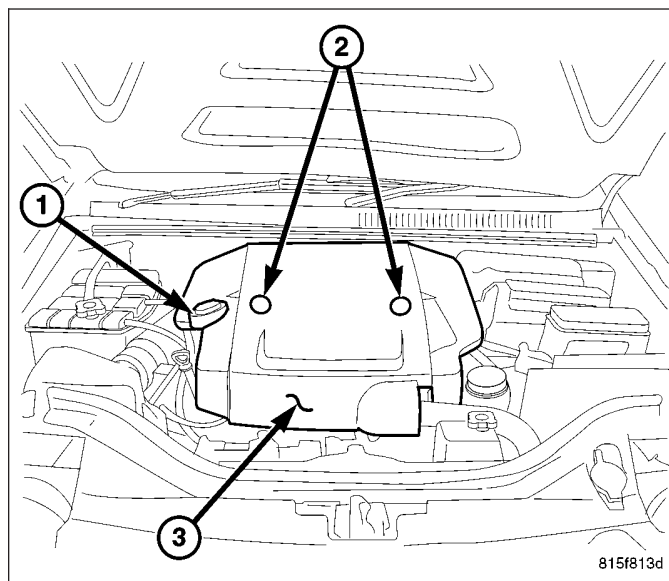
1. Measure and record internal diameter of valve guides. Valve guide internal diameter is 6.0 to 6.012 mm (0.2362 to 0.2366 in.).
2. Measure valve stems and record diameters. Intake valve stem diameter 5.952 to 5.97 mm (0.2343 to 0.2350 in). Exhaust valve stem diameter 5.942 to 5.96 mm (0.2339 to 0.2346 in).
3. Subtract diameter of valve stem from internal diameter of its respective valve guide to obtain valve stem clearance in valve guide. Clearance of inlet valve stem in valve guide is 0.03 to 0.06 mm (.0011 to .0023 in). Clearance of exhaust valve stem in valve guide is 0.04 to 0.07 mm (.0015 to .0027 in).
4. If valve stem clearance in valve guide exceeds tolerances, new valve guides must be installed .



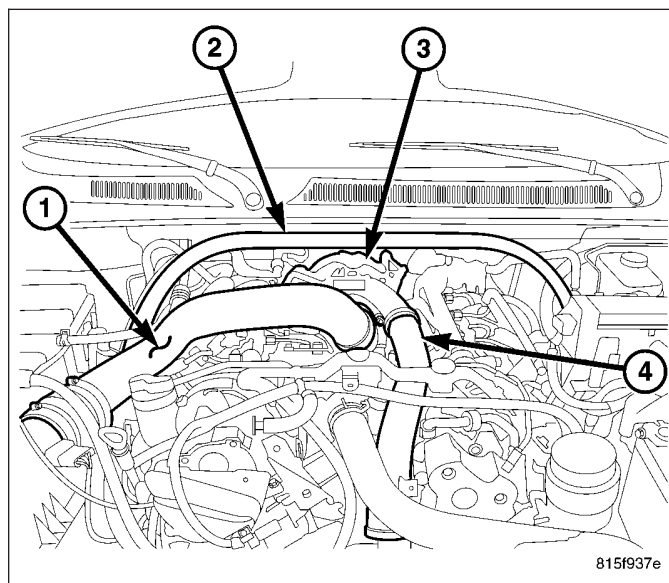
## REMOVAL

### LEFT

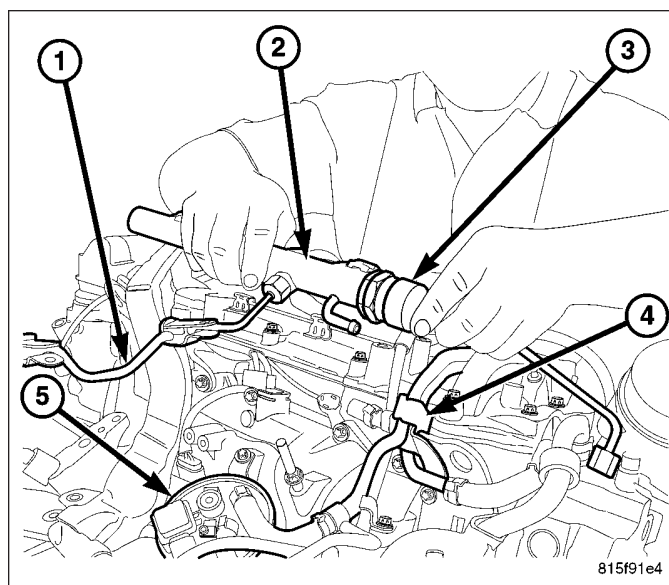
1. Disconnect negative battery cable.
2. Remove engine cover (3) and brackets.



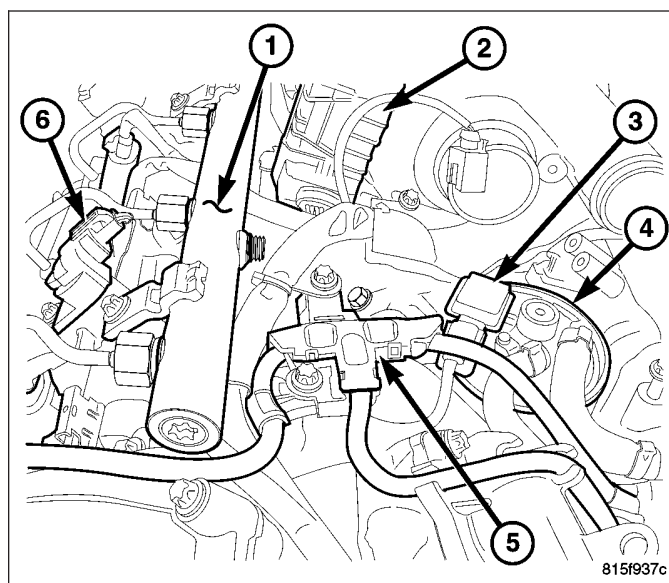
3. Remove the strut tower support (2).
4. Remove the air cleaner outlet tube (1).
5. Remove the charge air inlet tube (4).
6. Drain cooling system.
7. Disconnect the vacuum hose at the vacuum pump and set aside.
8. Remove upper radiator hose.
9. Disconnect the coolant reservoir hose at thermostat housing and set aside.



10. Disconnect the fuel supply and return hose quick connects at the left cylinder head cover.
11. Loosen the high pressure fuel pipes at the fuel rail (2) and disconnect the high pressure fuel pipes at the left injectors.
12. Disconnect the high pressure fuel line at the high pressure pump.
13. Disconnect the fuel rail solenoid (3) wiring harness connector and remove the left fuel rail (2) along with the fuel rail transfer pipe (1).
14. Remove the low pressure fuel supply and return pipe bundle (4) fasteners.

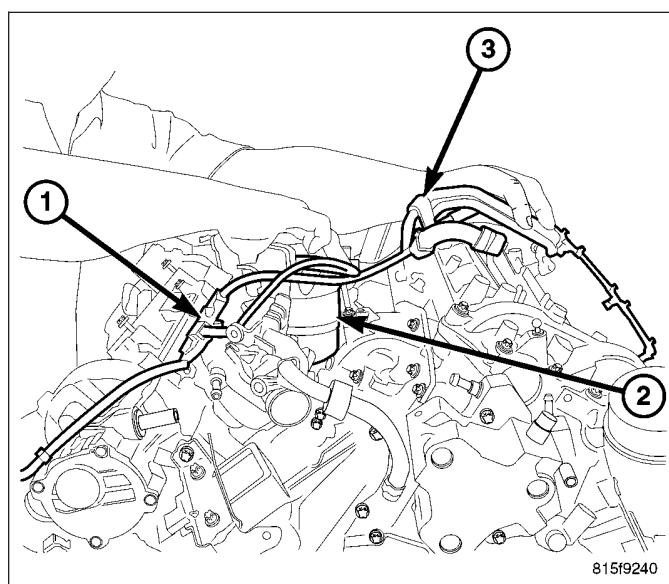


15. Disconnect the right fuel rail pressure sensor and remove the fuel rail.
16. Disconnect the camshaft position sensor (CMP) (6), the right fuel injector wiring harness connectors, the right return fuel hoses from the injectors.
17. Remove the return fuel bundle fasteners (5).
18. Disconnect the water in fuel sensor (3) and the turbocharger servo motor (2) harness connectors.
19. Remove the fuel filter (4) bracket fasteners.
20. Disconnect the fuel return hose bundle (5), engine ground strap, at the right front of the intake manifold.



**NOTE:** Fuel filter assembly, hoses and lines may seep fuel. Capture any fuel spillage and store in appropriately marked containers.

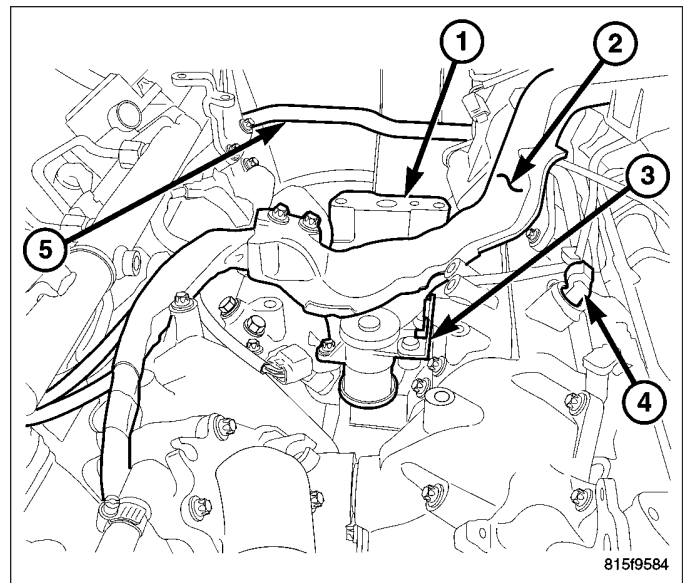
21. Remove the fuel filter (2), hose (1) and pipe (3) assemblies and position aside.



22. Remove the turbocharger (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - REMOVAL).

**NOTE:** Observe the way the engine oil supply and return ports in the turbocharger adaptor housing align to the engine block for oil flow through the turbocharger. Failure to do so will result in immediate turbocharger failure.

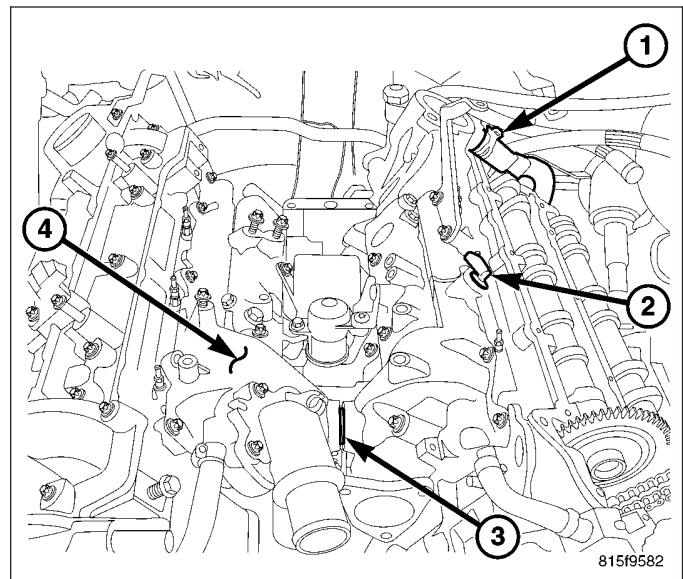
23. Remove turbocharger oil housing adaptor (1).  
 24. Disconnect the swirl valve actuator (3), glow plugs, EGR pressure sensor and coolant temperature sensor (4) wiring harness connector.  
 25. Remove the main engine wiring harness (2) fasteners and position the harness aside.



26. Disconnect the EGR coolant pipe (1) from the rear of the EGR housing.  
 27. Remove the EGR valve.

**NOTE:** The intake manifold is of the split design meaning that there are two halves. Whenever the intake manifold is removed, inspect the shared coolant passage (3) in the front of the intake manifold for leaks, repair as necessary.

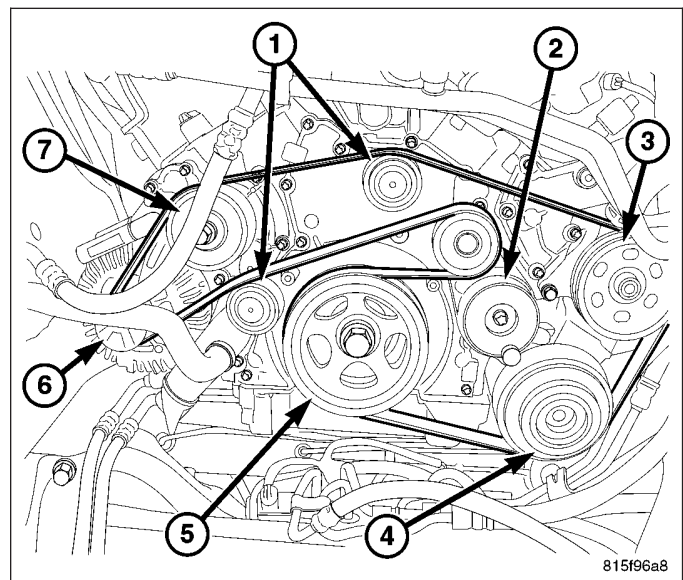
28. Remove the intake manifold.



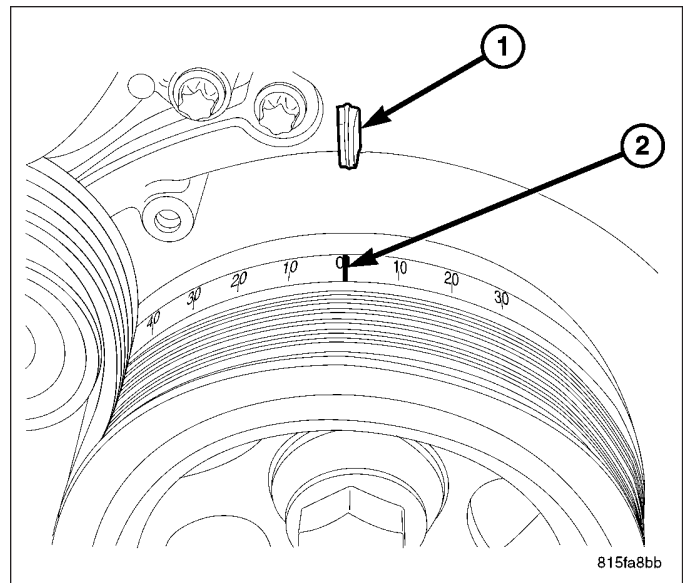
29. Remove the accessory drive belt.

**CAUTION:** The idler pulley retaining bolts are L.H. thread.

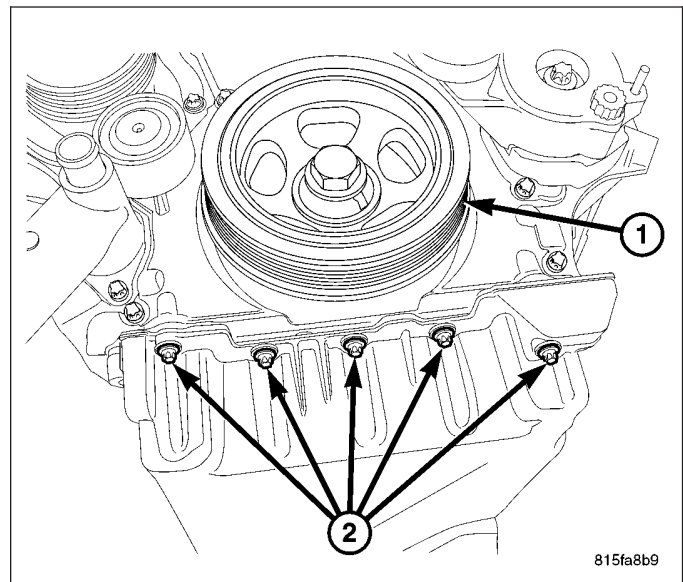
30. Remove the two idler pulleys (1).  
 31. Remove the belt tensioner (2).



32. Rotate the engine by the vibration damper bolt, to TDC.
33. Raise and support the vehicle.
34. Remove right side starter blank.
35. Disconnect the hydraulic cooling fan lines and capture the fluid in a approved and clearly marked container.



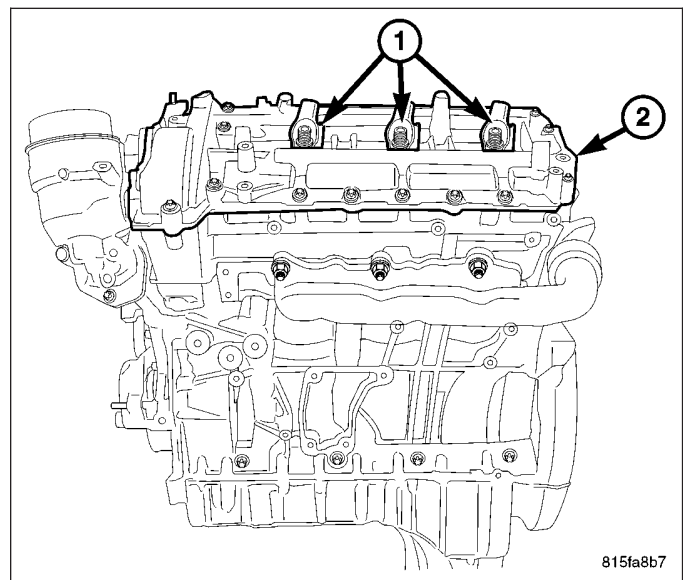
36. Remove the front oil pan retaining bolts (2).
37. Lower the vehicle.



38. Remove the left rear heater hose retainer.
39. Remove the left fuel injectors (1).
40. Disconnect the vacuum supply hose.
41. Remove the oil filter housing bracket.

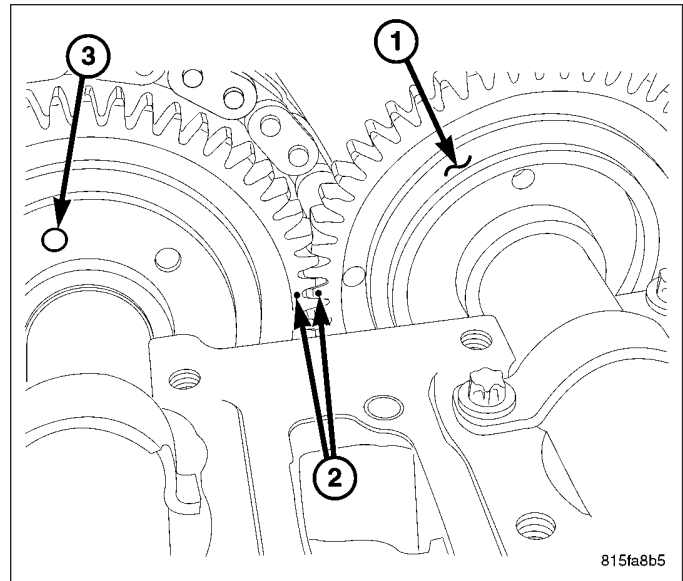
**CAUTION:** The timing cover is sealed with Mopar sealant that may be difficult when separating components. If the component are difficult to separate heat the sealed edges or area with a heat gun. **DO NOT** use any heat source that works with flame.

42. Remove the left cylinder head cover.

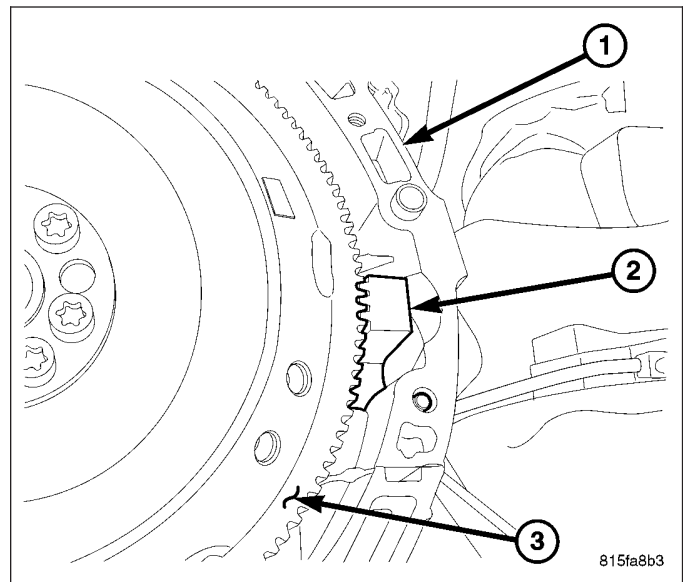




43. Observe the left camshaft gear alignment marks (2) on the rear of the camshaft gears (1,3). If they are together, continue with the next step. If the left camshaft alignment marks (2) are separated, rotate the engine by the vibration damper another 360°, until camshaft marks (2) align together and the vibration damper reaches TDC.



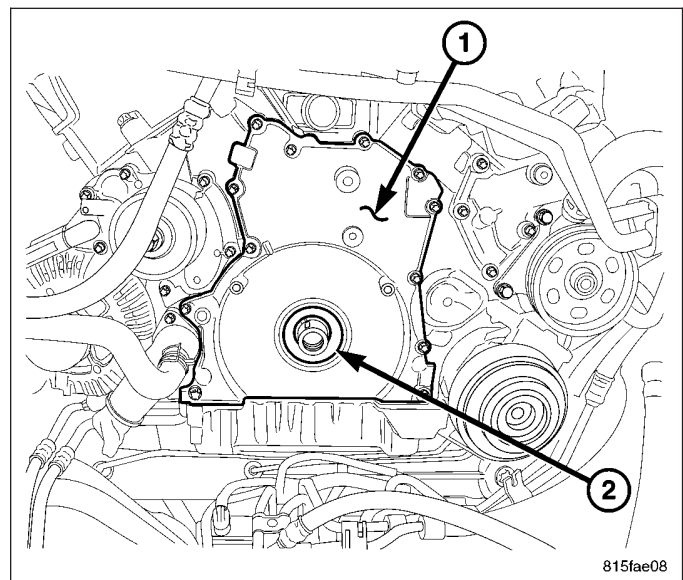
44. Raise and support the vehicle.  
45. Install special tool #9102 crankshaft lock into the starter access blank.  
46. Lower the vehicle.



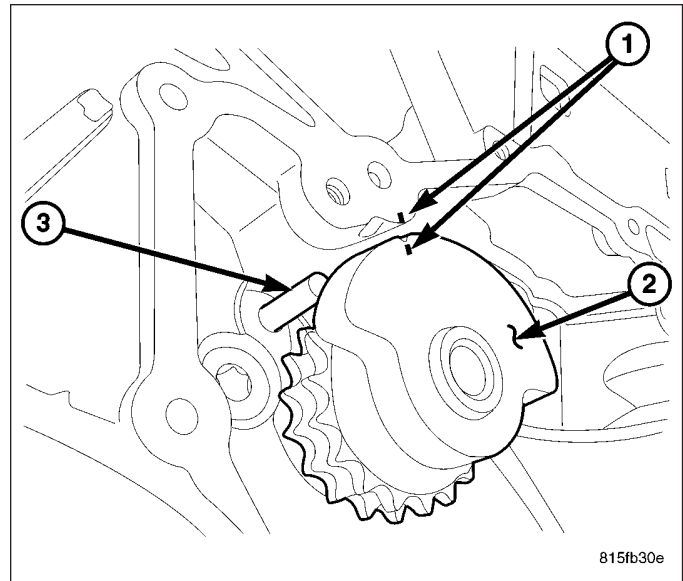
47. Remove the cooling fan module.  
48. Remove the vibration damper.

**CAUTION:** The timing cover is sealed with Mopar sealant that may be difficult when separating components. If the component are difficult to separate heat the sealed edges or area with a heat gun. DO NOT use any heat source that works with flame.

49. Remove front timing chain cover.



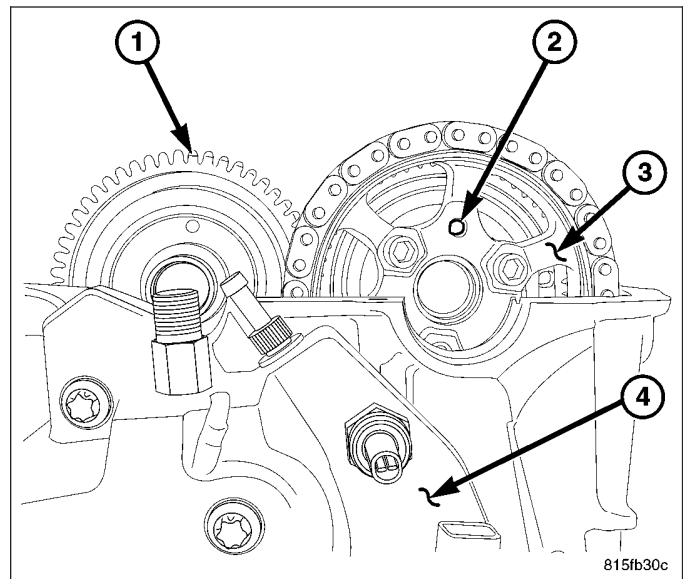
50. Paint mark or scribe the balance shaft (2) position to the engine block (1) and timing chain.
51. Paint mark or scribe the timing chain to crankshaft gear and camshaft drive gear relation.
52. Raise and support the vehicle.
53. Remove special tool #9102 crankshaft locking tool.
54. Lower the vehicle.



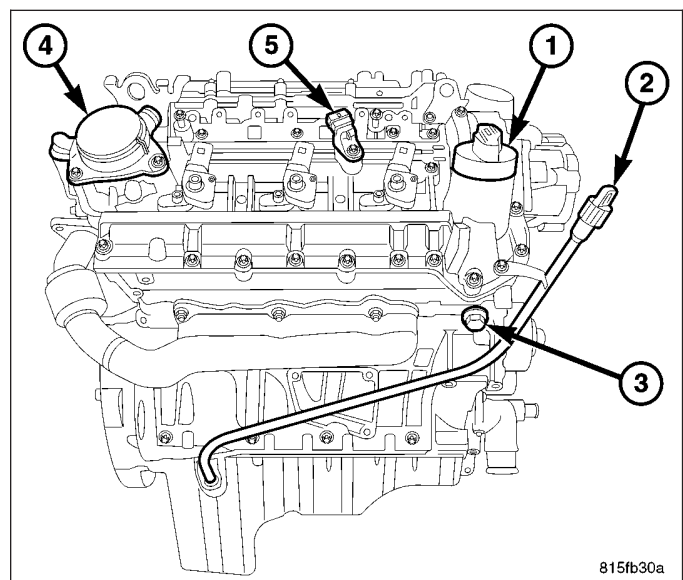
55. Remove the high pressure fuel pump (4) (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL INJECTION PUMP - REMOVAL).
56. Rotate the engine and remove the left camshaft drive gear (3) lower bolt.

**NOTE:** The left exhaust camshaft drive gear (3) dowel pin should align at approximately the 12 O'clock position when viewing through the camshaft seal access hole.

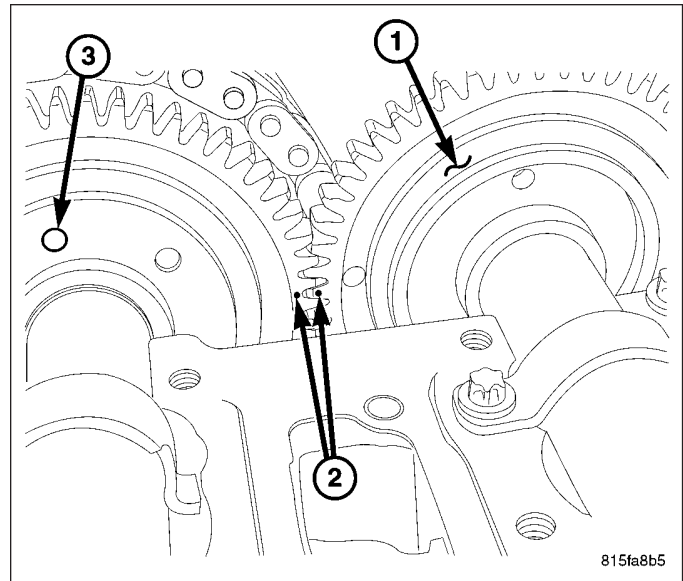
57. Rotate the engine back to TDC and check the alignment marks at the balance shaft, camshaft gear and crankshaft gear.



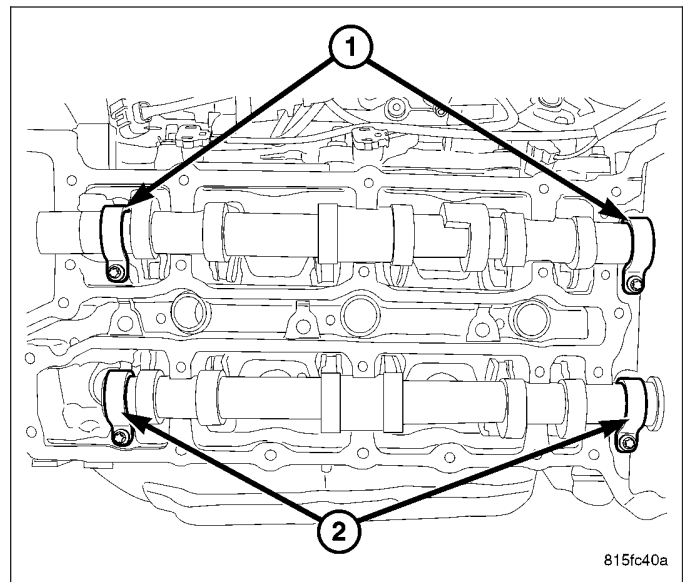
58. Remove the timing chain tensioner (3).



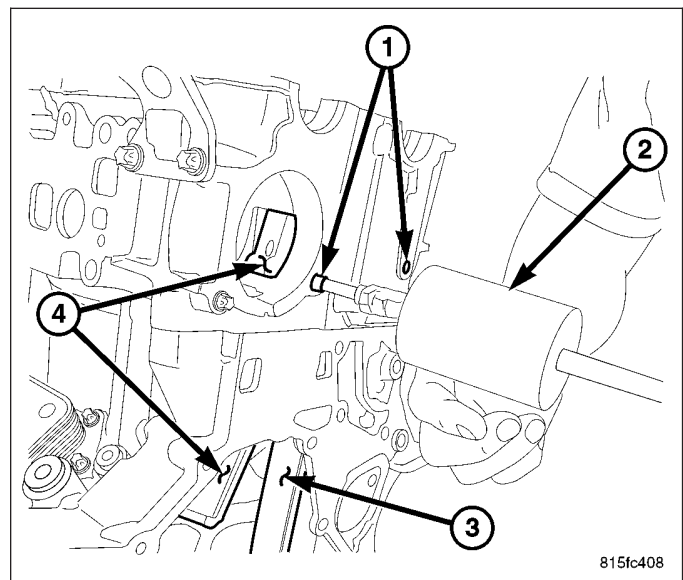
59. Remove the remaining left camshaft drive gear (3) retaining bolts.
60. Separate the left camshaft drive gear (3) and chain from camshaft.



61. Remove the left camshaft retainers (1 and 2) and camshafts.
62. Remove the left camshaft drive gear.



63. Using a slide hammer (2) and a screw, remove the left upper timing chain guide (4) retaining pin (1).
64. Using a slide hammer and a screw, remove the left lower timing chain guide retaining pin (1).

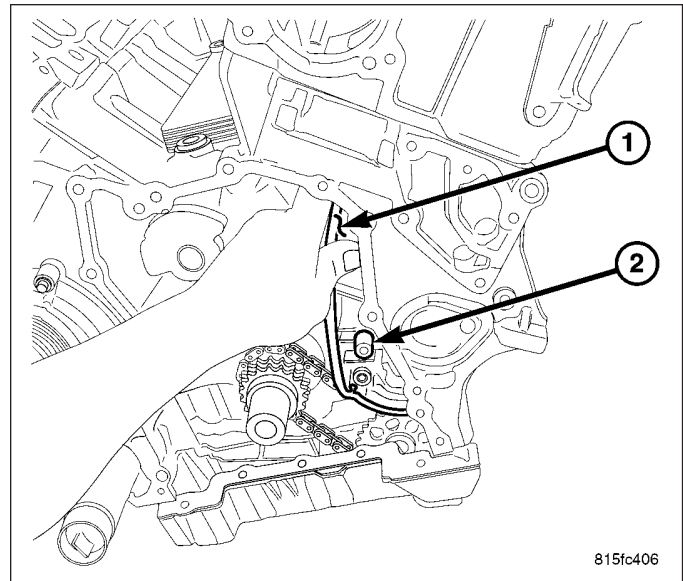




65. Remove the left lower timing chain guide fastener (2) and guide (1).

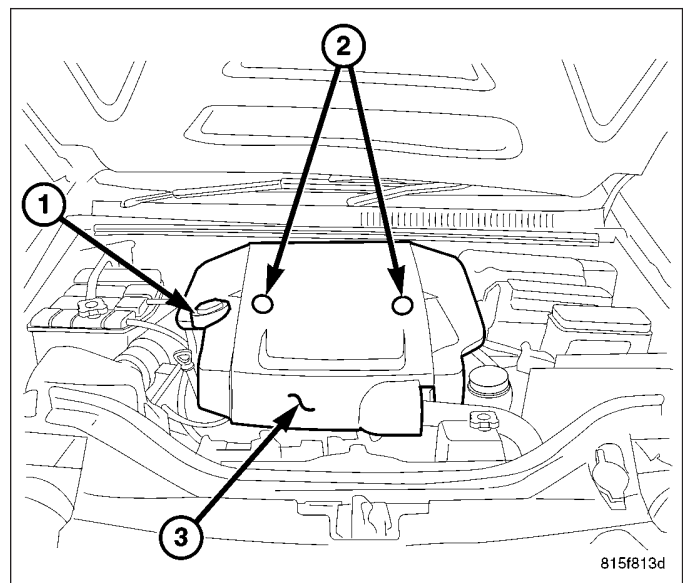
**NOTE: Do Not store the cylinder head on the sealing surface. The glow plugs protrude into the cylinder surface area and may be damaged.**

66. Remove the left cylinder head glow plugs.  
67. Remove cylinder head and gasket from engine block.

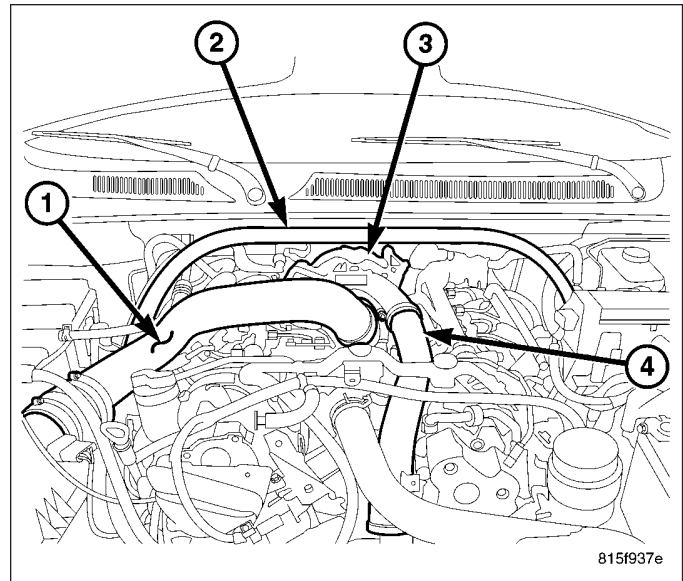


## RIGHT

1. Disconnect negative battery cable.  
2. Remove engine cover (3) and brackets.



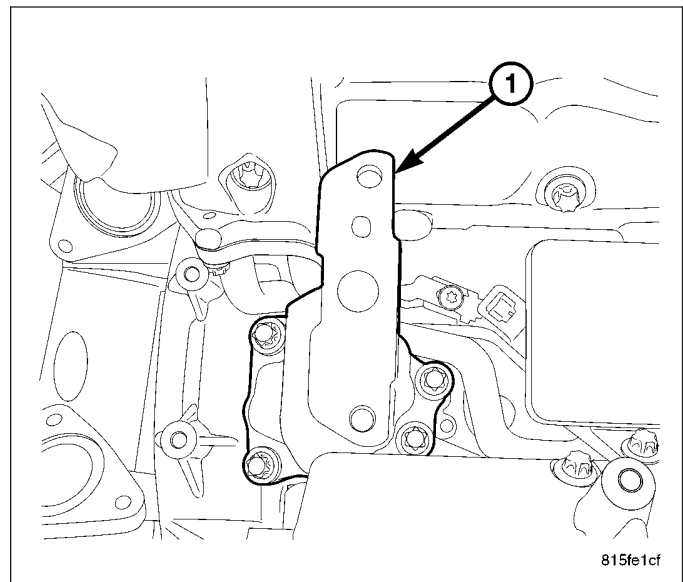
3. Remove the strut tower support (2).
4. Drain cooling system.



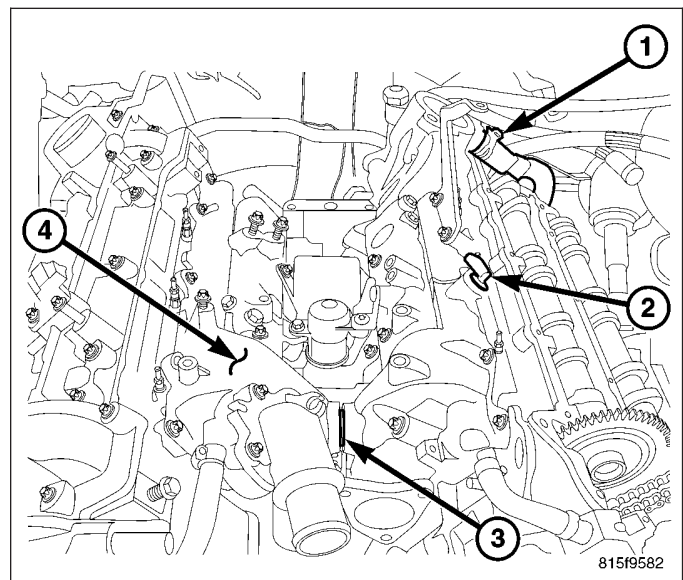
5. Remove the turbocharger (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - REMOVAL).

**NOTE:** Observe the way the engine oil supply and return ports in the turbocharger adaptor align to the engine block for oil flow through the turbocharger. Failure to do so will result in immediate turbocharger failure.

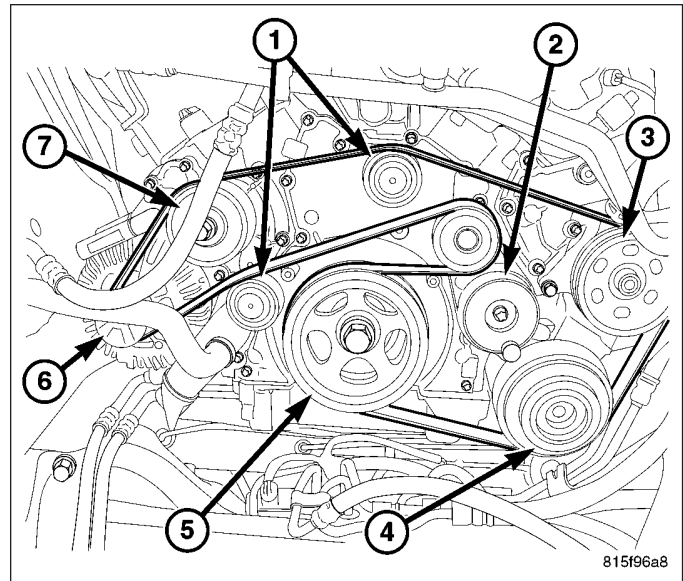
6. Remove turbocharger oil housing adaptor (1).



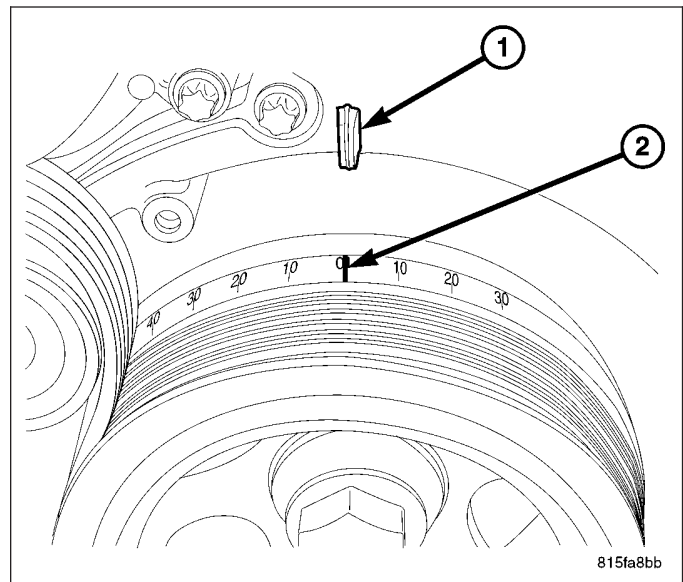
7. Remove the intake manifold.



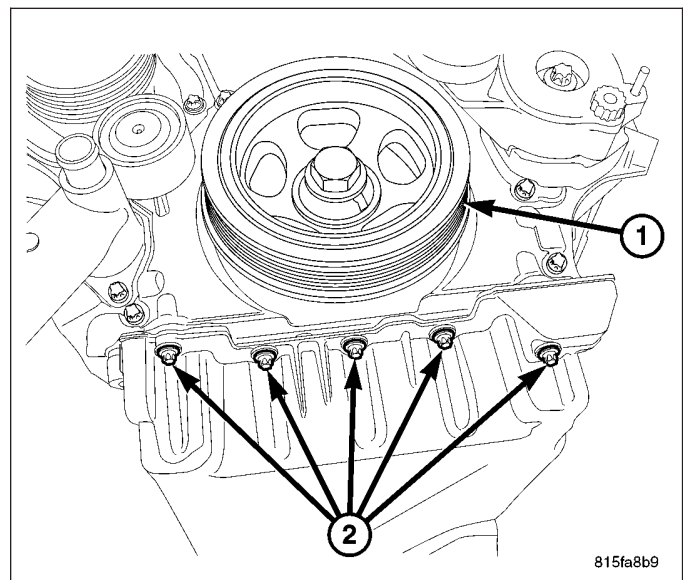
8. Remove the accessory drive belt.
9. Remove the two idler pulleys (1).
10. Remove the belt tensioner (2).



11. Rotate the engine by the vibration damper bolt, to TDC.
12. Raise and support the vehicle.
13. Remove right side starter blank.
14. Disconnect the hydraulic cooling fan lines and capture the fluid in a approved and clearly marked container.



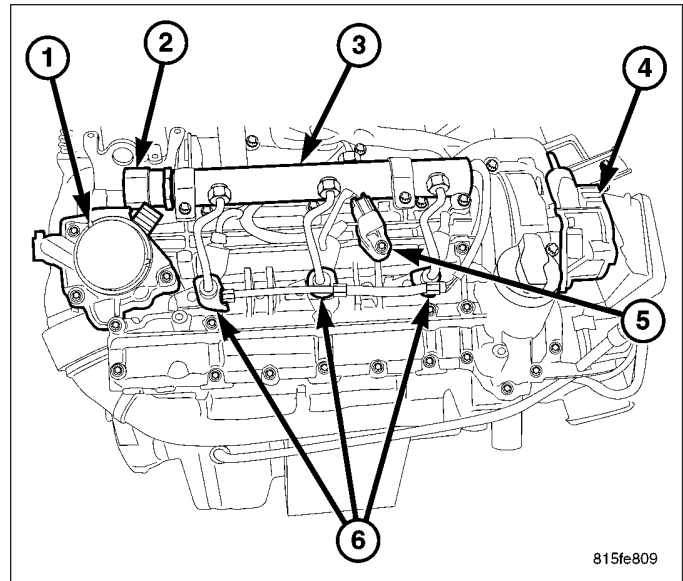
15. Remove the front oil pan retaining bolts.
16. Lower the vehicle.



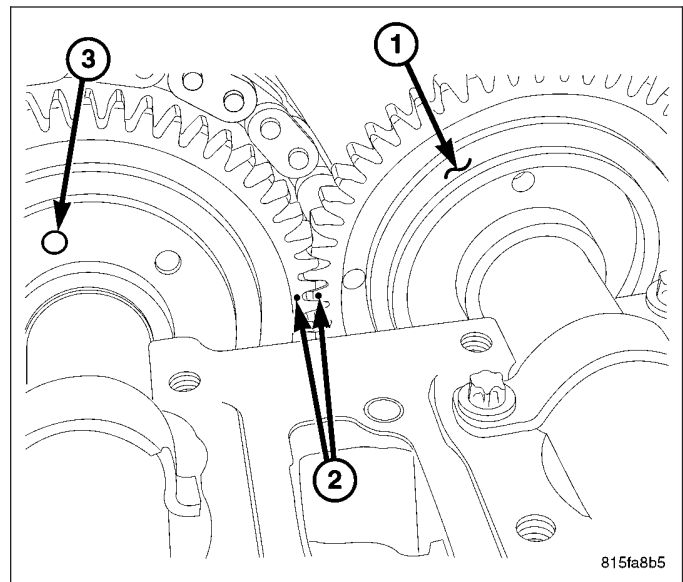
17. Remove the breather / oil separator (1) assembly from the right cylinder head cover.
18. Remove the right fuel injectors (6).
19. Remove the fuel rail (3).
20. Disconnect the vacuum supply hose from the vacuum pump (4).
21. Remove the vacuum pump (4).

**NOTE:** If the cylinder head cover is difficult to remove, **DO NOT PRY** or damage the cover. Use a heat gun to warm the sealing surface until the cover can be removed.

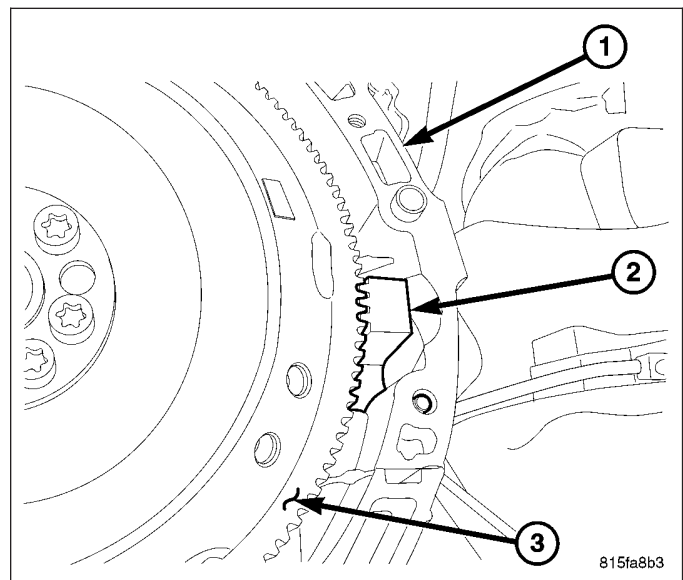
22. Remove the right cylinder head cover.



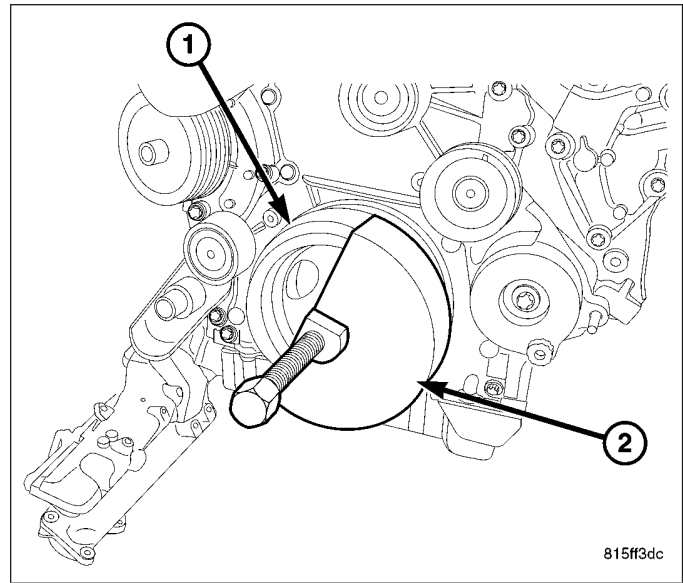
23. Observe the right camshaft gear alignment marks (2). If they are together, continue with the next step. If the right camshaft alignment marks are separated, rotate the engine by the vibration damper until camshaft marks align together and the vibration damper reaches TDC.



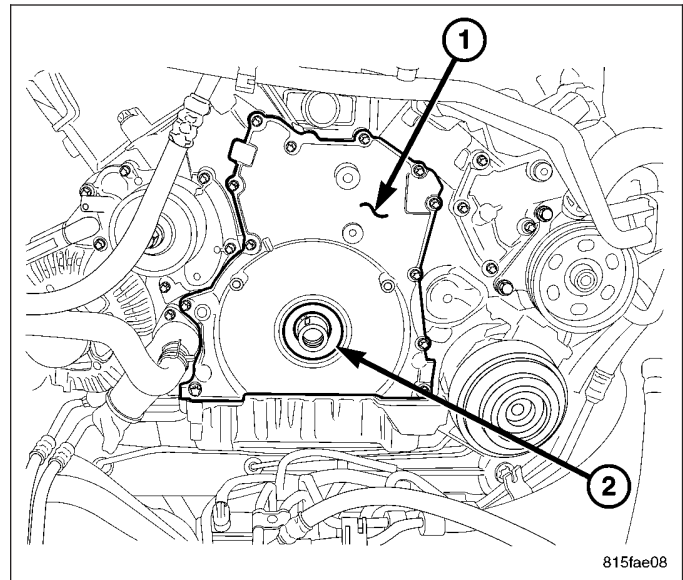
24. Raise and support the vehicle.
25. Install special tool #9102 crankshaft lock (2).



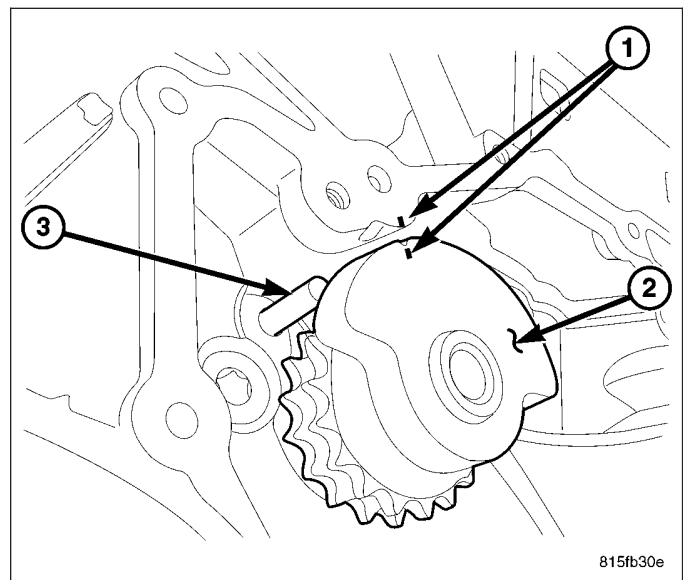
26. Lower the vehicle.
27. Remove the cooling fan module.
28. Remove the vibration damper (1) using special tool # 9944 (2).



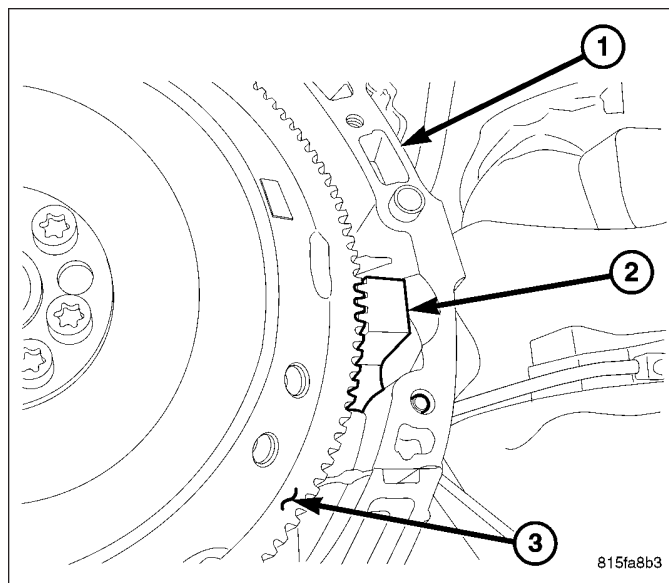
29. Remove front timing chain cover (1).



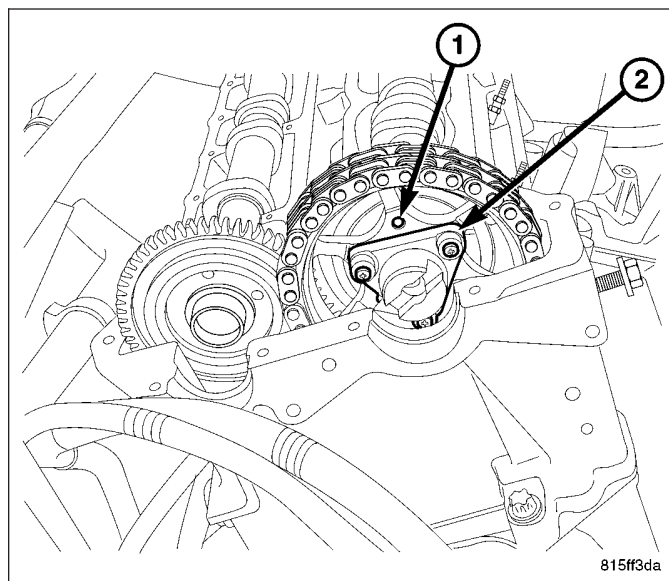
30. Paint mark or scribe the balance shaft (2) position to the engine block and timing chain.
31. Paint mark or scribe the timing chain to crankshaft gear and camshaft drive gear relation.



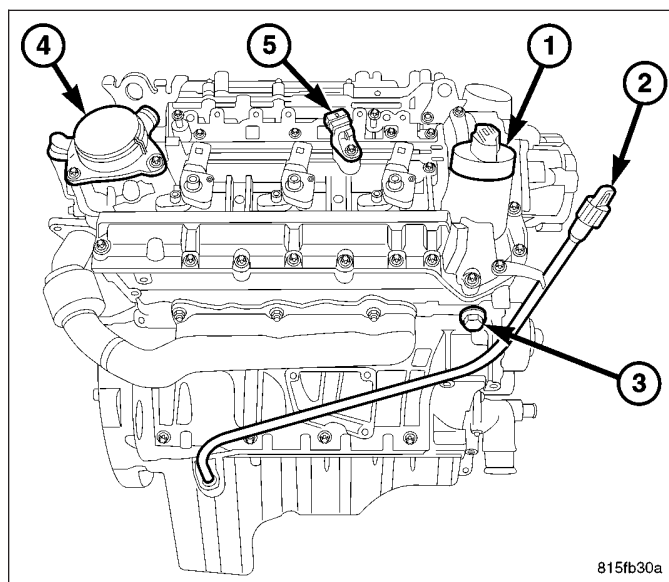
- 32. Raise and support the vehicle.
- 33. Remove special tool #9102 crankshaft locking tool (2).
- 34. Lower the vehicle.



- 35. Rotate the engine and remove the right camshaft drive gear (1) lower bolt.
- 36. Rotate the engine back to TDC and check the alignment marks at the balance shaft, camshaft gear and crankshaft gear.

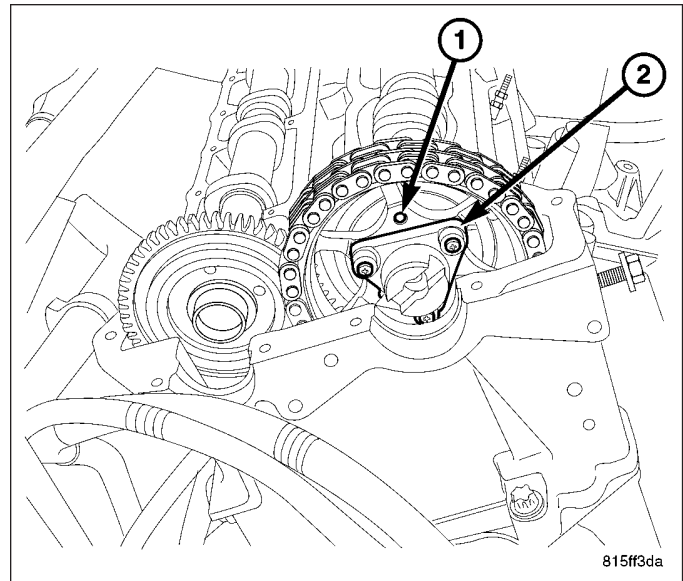


- 37. Remove the timing chain tensioner (3).

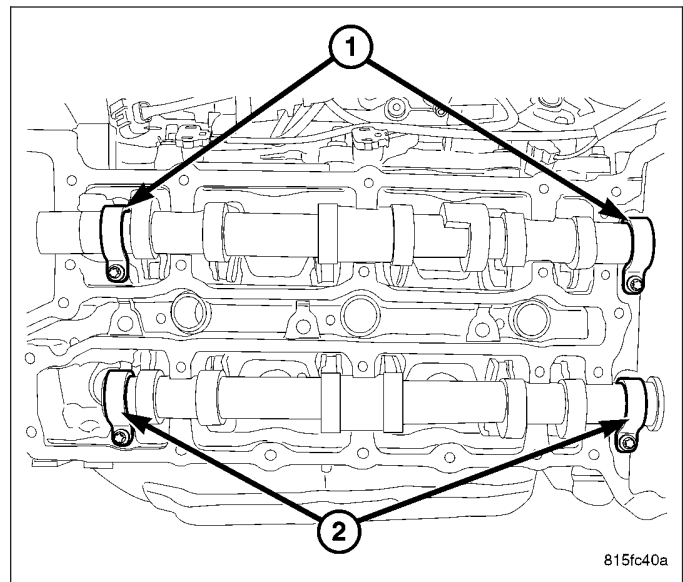




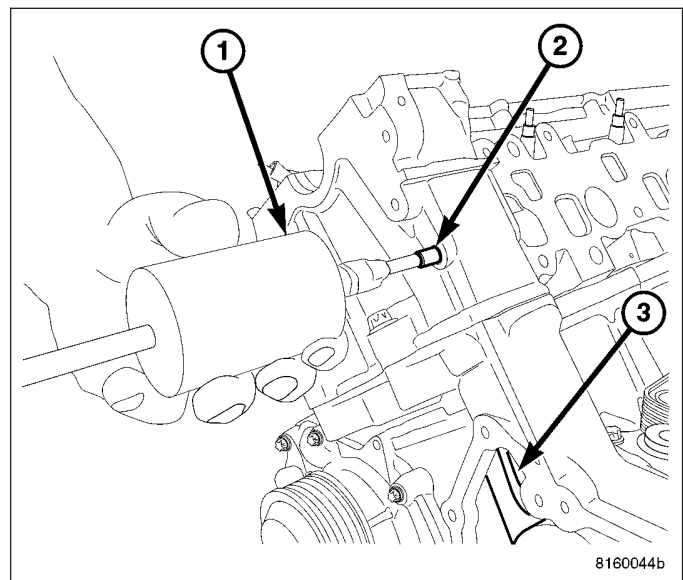
38. Remove the remaining right camshaft drive gear (1) retaining bolts.
39. Separate the right camshaft drive gear (1) and chain from camshaft.
40. Remove the right camshaft drive gear (1).



41. Remove the right camshafts retainers (1,2) and camshafts.



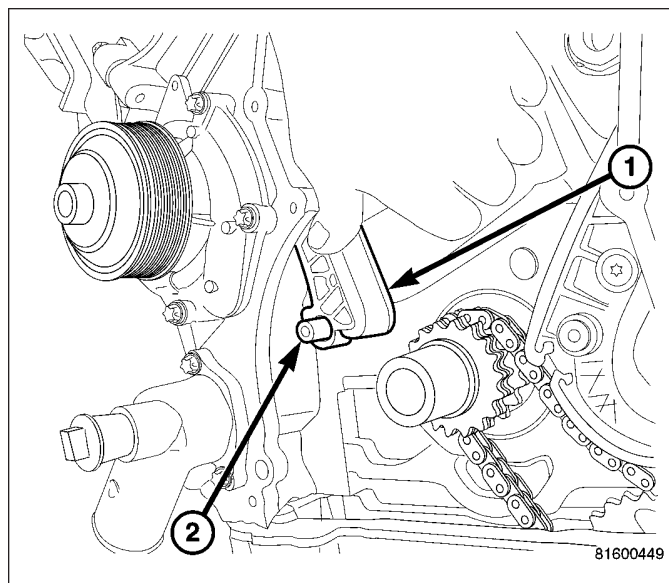
42. Remove the right upper timing chain upper guide (3).



43. Remove the right lower timing chain guide (1).

**NOTE:** Do Not store the cylinder head on the sealing surface. The glow plugs protrude into the cylinder surface area and may be damaged.

44. Remove the right cylinder head glow plugs.  
45. Remove cylinder head and gasket from engine block.



## CLEANING

Thoroughly clean the engine cylinder head and cylinder block mating surfaces. Clean the intake and exhaust manifold and engine cylinder head mating surfaces. Clean the injector bores. Remove all gasket material and carbon.

Check to ensure that no fuel injector washer seals are left in the injector bores.

Check to ensure that no coolant or foreign material has fallen into the tappet bore area.

Remove the carbon deposits from the combustion chambers and top of the pistons.

## INSPECTION

Use a straightedge and feeler gauge to check the flatness of the engine cylinder head and engine block mating surfaces.

The minimum cylinder head thickness is 128.35 mm (5.0532 in.).

## INSTALLATION

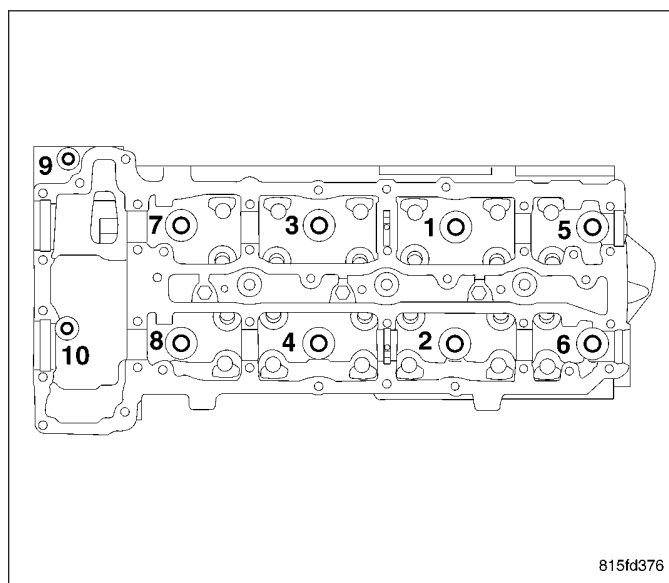
### LEFT

**CAUTION:** Inspect and measure all cylinder head bolt lengths. If out of specification, replace as necessary (Refer to 9 - ENGINE/CYLINDER HEAD - STANDARD PROCEDURE).

1. Clean and inspect gasket mating surfaces (Refer to 9 - ENGINE/CYLINDER HEAD - CLEANING).
2. Position correct head gasket on engine block.
3. Place cylinder head on engine block.

**CAUTION:** If new cylinder head bolts are used, do not lubricate the new cylinder head bolts. They already are coated with an anti scuff treatment.

4. Tighten cylinder head bolts following procedure below.
  - a. Tighten M12 cylinder head bolts 1 through 8, in the sequence shown to 60 N·m (44 ft. lbs.).
  - b. Tighten M8 bolts 9 and 10 to 20 N·m ( 177 in. lbs.).

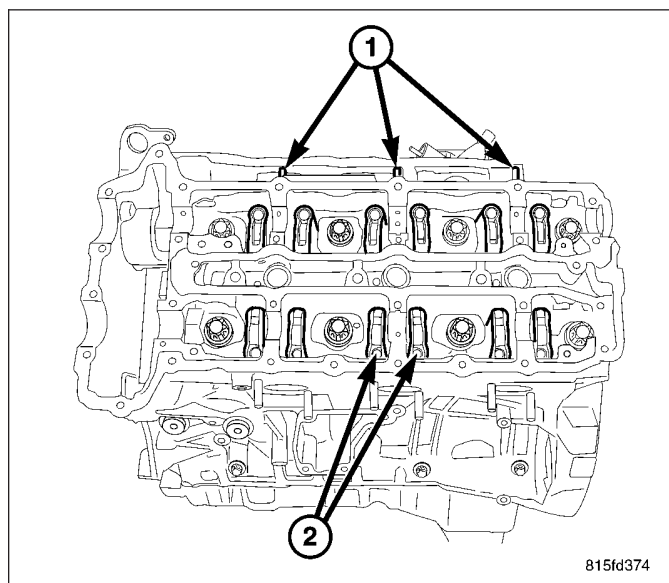




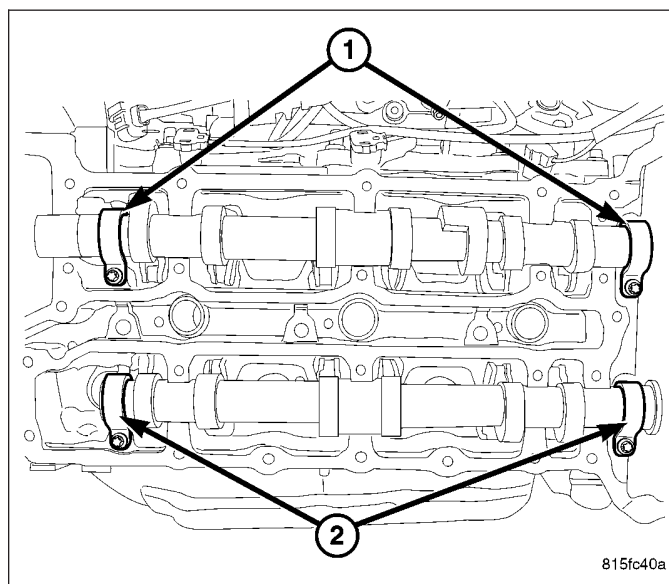
- c. Tighten M12 cylinder head bolts 1 through 8, in the sequence shown an additional 90 degrees.
- d. Recheck and tighten M8 bolts 9 and 10 to 20 N·m ( 177 in. lbs.).
- e. And then again, Tighten M12 cylinder head bolts 1 through 8, in the sequence shown an additional 90 degrees.

**NOTE: Followers and tappets assemblies must be installed in same location as removed.**

- 5. Install the followers (2) and tappets (2) into their original positions.
- 6. Install the glow plugs (1). Tighten glow plugs (1) to 15 N·m (133 in. lbs.).

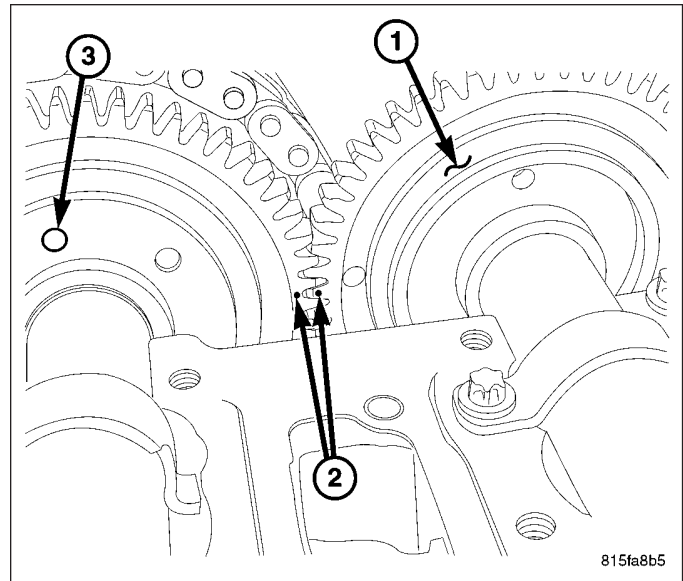


- 7. Install the left exhaust camshaft. Tighten the retaining (2) fasteners to 8 N·m (71 in. lbs.).
- 8. Install the left intake camshaft. Tighten the retaining (1) fasteners to 8 N·m (71 in. lbs.).

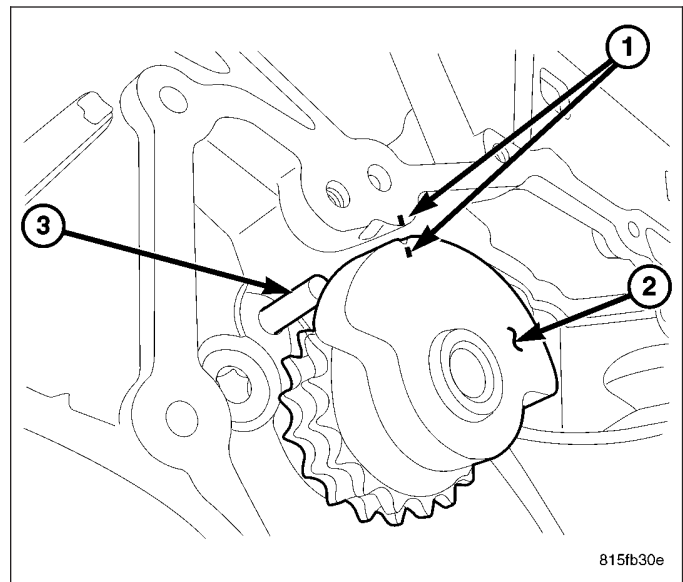


**NOTE:** Care must be taken to assure the proper exhaust camshaft to intake camshaft alignment is maintained. Before mating the drive gear to the camshaft gear a quick check will find the exhaust camshaft drive gear dowel (3) in the 12 O'clock position when viewed through the camshaft seal access hole.

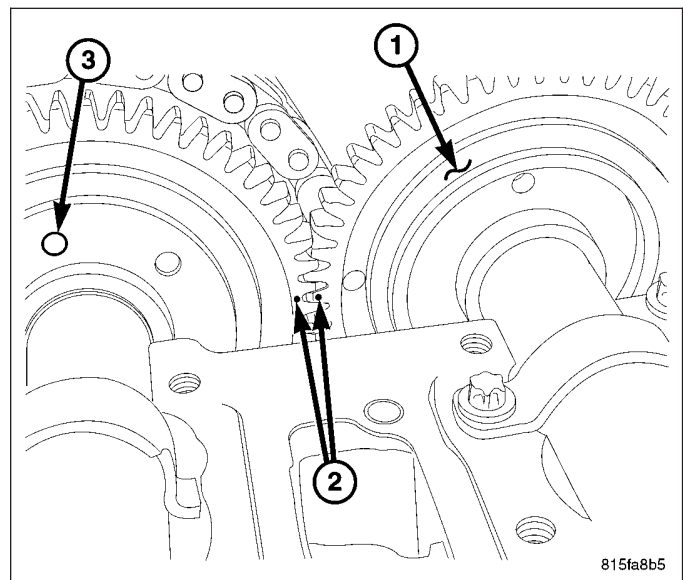
9. Align the camshaft marks (2) so the alignment marks are facing each other.
10. Insert the timing chain, through the cylinder head, and on to the camshaft drive gear.



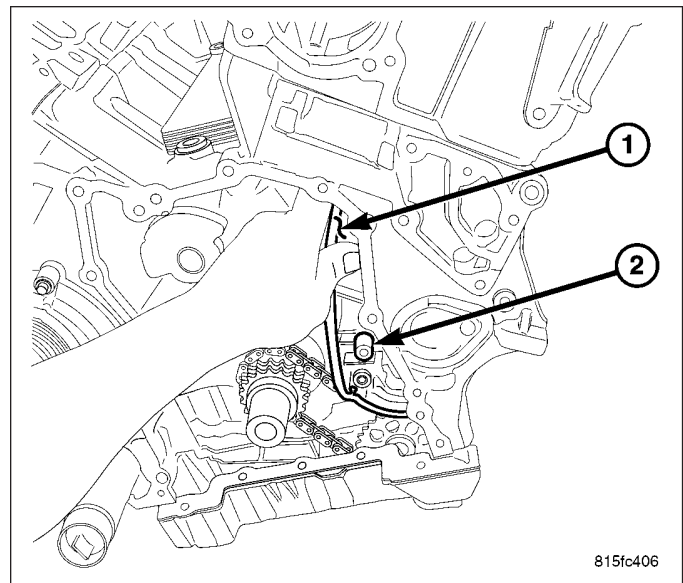
11. Align the balance shaft (2) with the scribe or paint mark.
12. Once the camshaft drive gear is mated with the timing chain, install the camshaft drive gear on to the camshaft and assure the balance shaft is aligned properly.



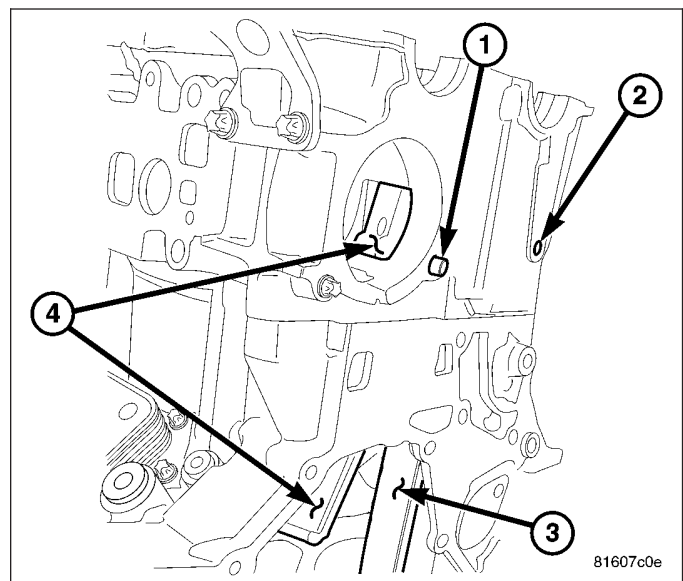
13. Install the upper two of the three camshaft drive gear bolts.



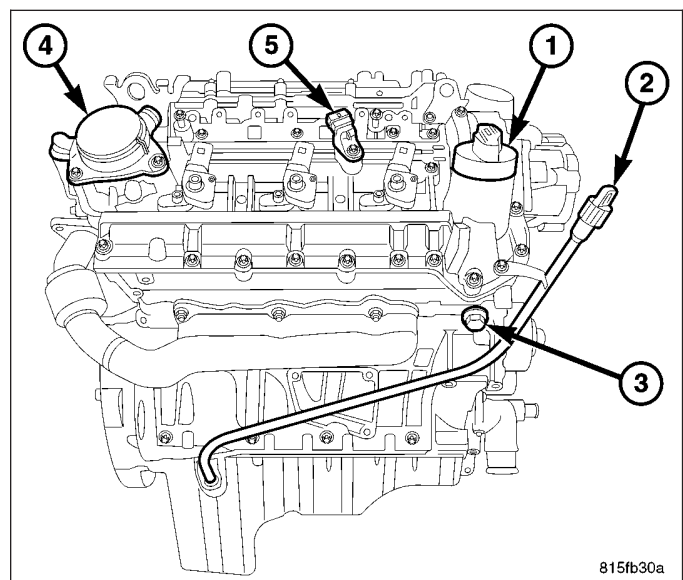
14. Install the left lower timing chain guide (1).



15. Install the left upper timing chain guide (4).



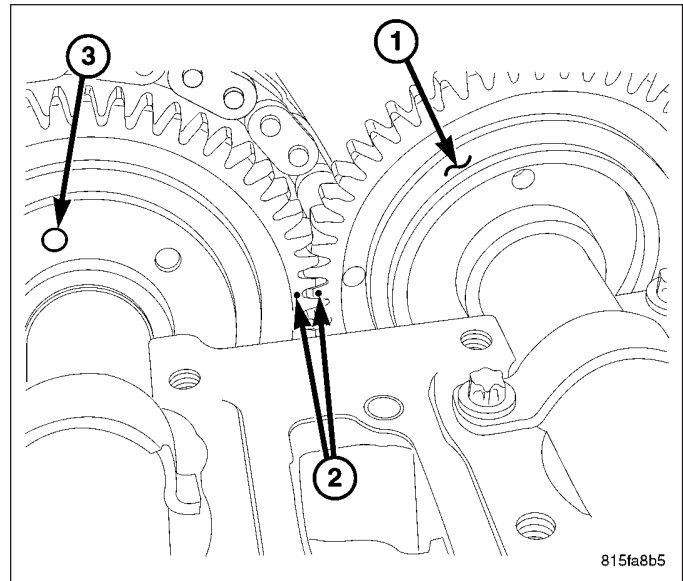
16. Install the timing chain tensioner (3).



17. Rotate the engine by the vibration damper bolt enough to gain access to the third camshaft drive gear bolt hole.
18. Install the third camshaft drive gear retaining bolt and tighten the bolt to 18 N·m (13 ft. lbs.).

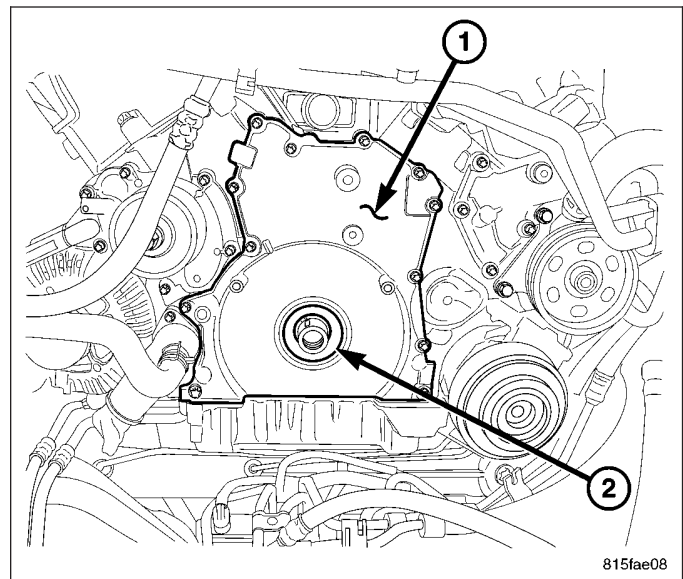
**WARNING:** If the camshaft, balance shaft and or crankshaft alignment marks are not aligned properly immediate damage to the engine will occur. If the camshafts, balance shaft and or crankshaft do not align properly after rotating the engine to the original starting point, STOP and begin the alignment procedure again.

19. Rotate the engine back to TDC by the vibration damper bolt until the crankshaft, camshaft and balance shaft align TDC again.

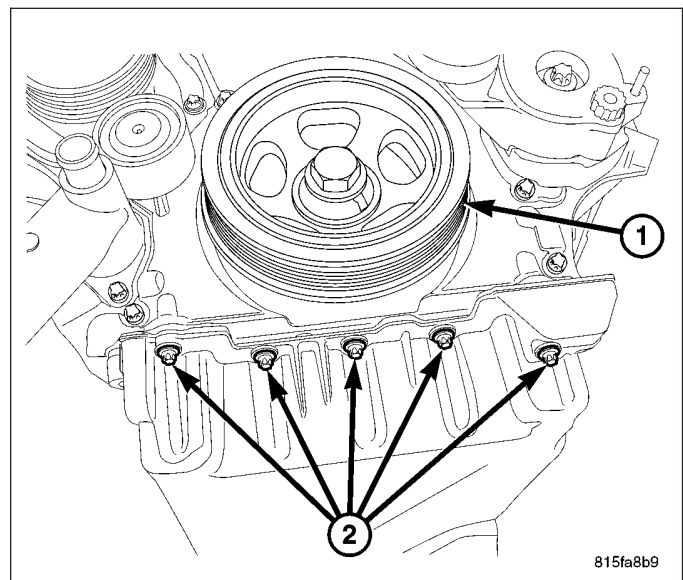


**WARNING:** Check that all the timing chain fits properly on all the timing gears. Failure to do so will result in immediate engine damage.

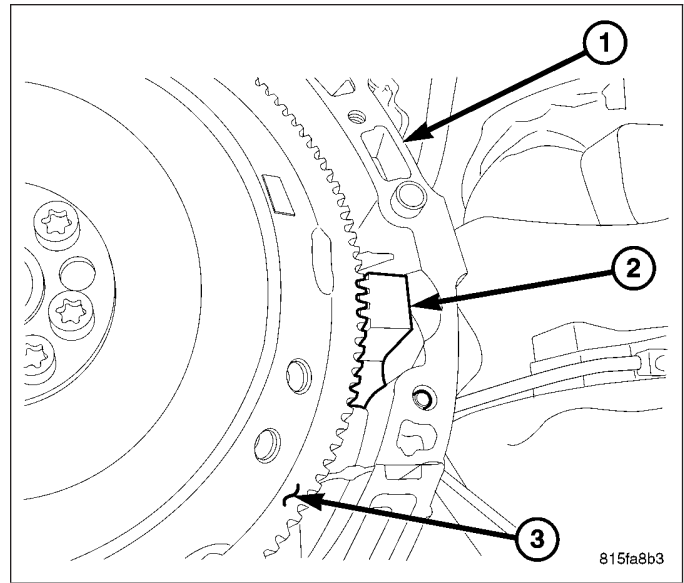
20. Apply a 1.5mm continuous bead of Mopar Engine Sealant RTV around the diameter of the timing chain cover (1) and Install the cover (1). Tighten the bolts to 8.4 N·m (74 in. lbs.).
21. Raise and support the vehicle.



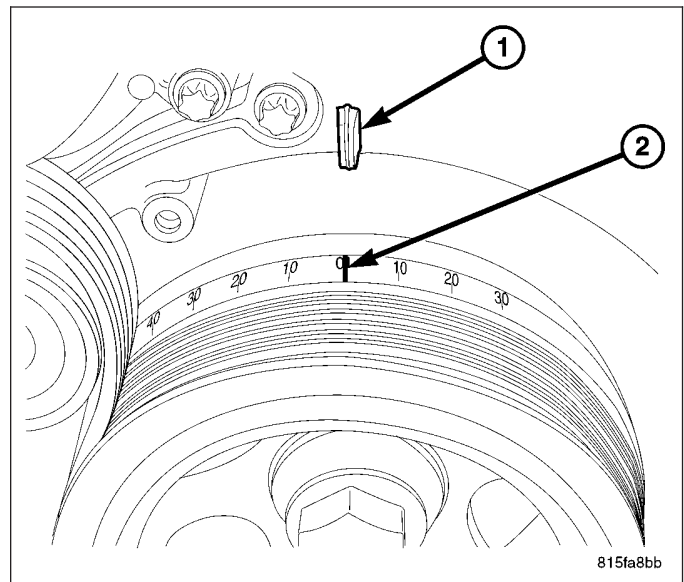
22. Install the 5 front oil pan to timing cover bolts. Tighten the bolts to 20 N·m (177 in. lbs.).



23. Install special tool #9102 crankshaft lock (2) into the starter access blank.
24. Lower the vehicle.

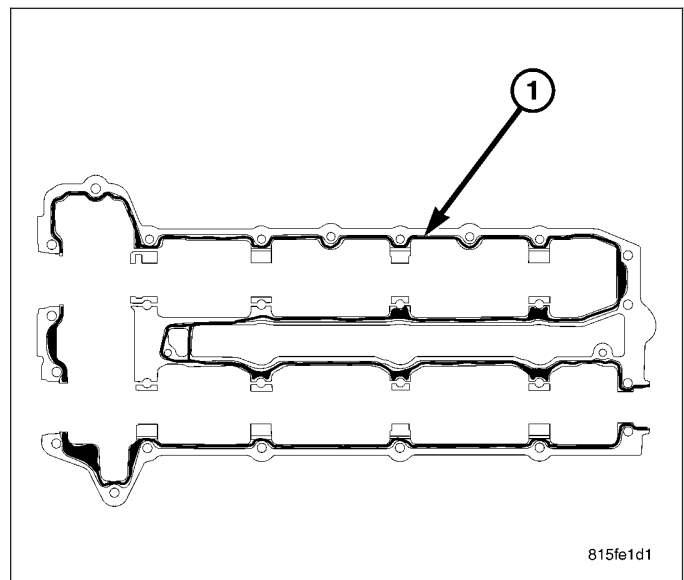


25. Install the vibration damper. Tighten the bolts to 200 N·m (148 ft. lbs.) and then an additional 90°.

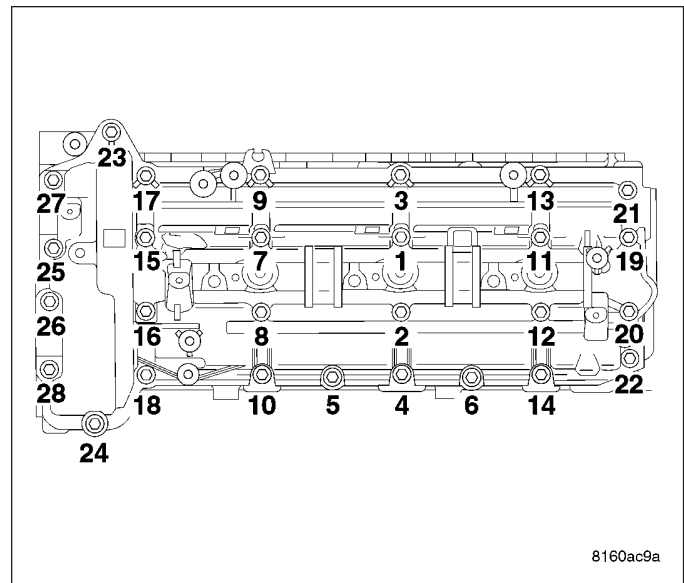


**NOTE:** Care must be taken not to get any engine sealer on the camshaft journals.

26. Apply a 1.5mm continuous bead of Mopar Engine Sealant RTV (1) around the diameter of the left cylinder head cover, and install the cover with new camshaft seals.



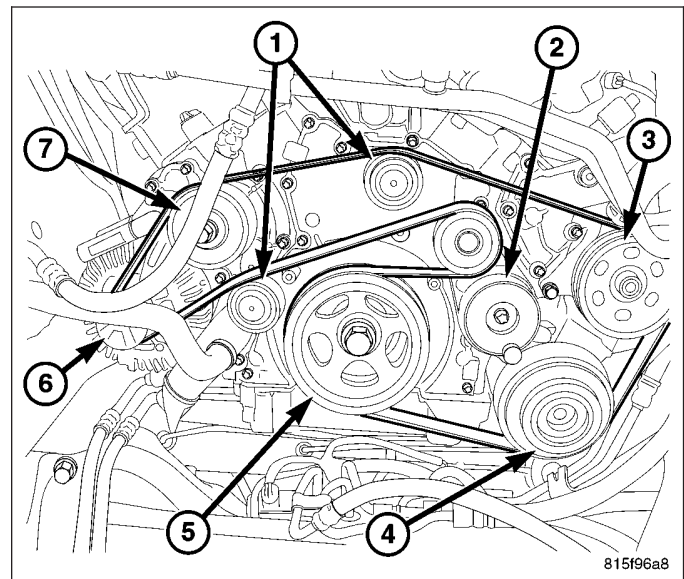
27. Tighten the bolts in three stages following the sequence provided. First to 4 N·M (35 in. lbs.), then to 6 N·M (53 in. lbs.), and then to 8.4 N·M (75 in. lbs.).



28. Install the oil filter housing bracket. Tighten the bolts to 13.8 N·m (122 in. lbs.).
29. Install the high pressure pump. Tighten bolts to 13.5 N·m (120 in. lbs.).

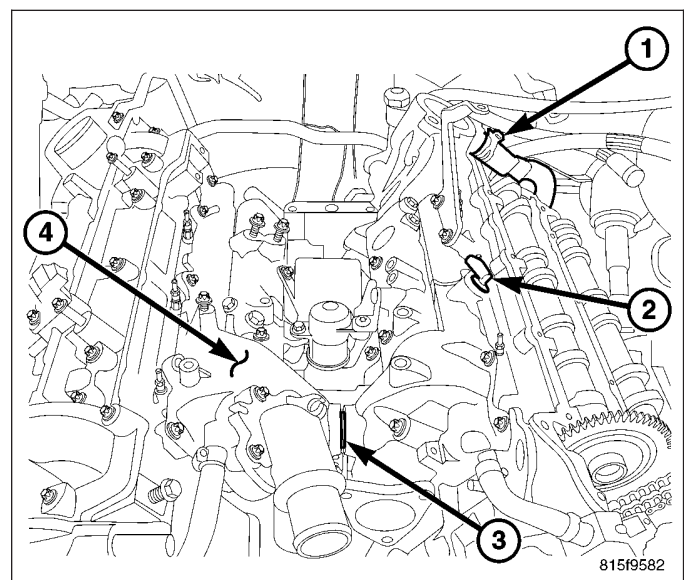
**NOTE: Idler pulley bolts are L.H. thread.**

30. Install the belt idler pulleys (1). Tighten the bolts to 58 N·m (43 ft. lbs.).
31. Install the drive belt tensioner (2). Tighten the bolts to 58 N·m (43 ft. lbs.).
32. Install the drive belt.



**CAUTION: The right intake manifold upper thermostat housing bolts should be tightened to 8.4 N·m (74 in. lbs.).**

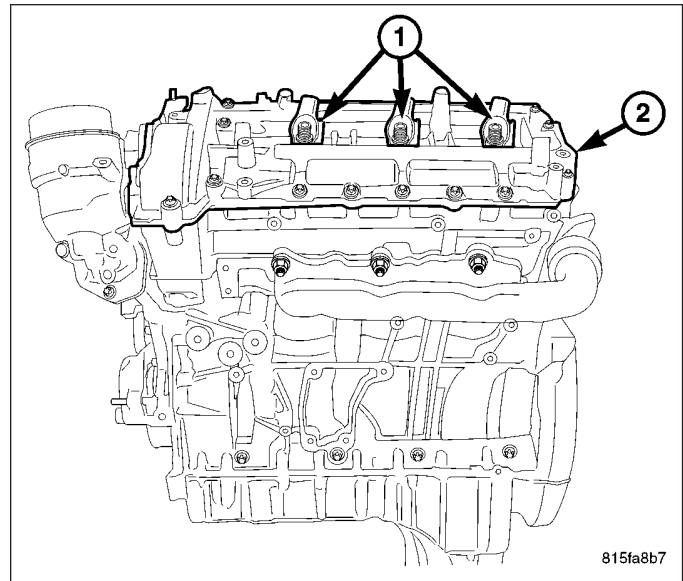
33. Install the intake manifold (4). Tighten bolts to 16 N·m (142 in. lbs.), starting in the middle and tightening in a cross pattern outward until reaching the upper thermostat bolts on the right front manifold.
34. Tighten the upper thermostat bolts on the right cylinder head to 8.4 N·m (74 in. lbs.).



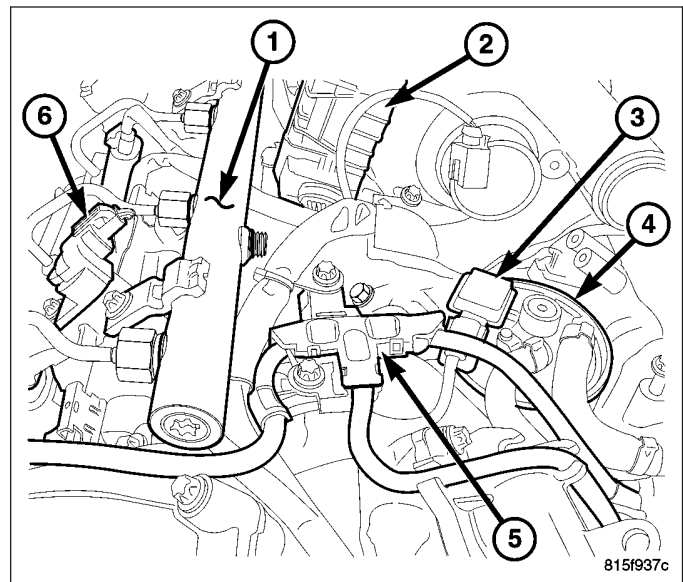


**CAUTION:** The fuel injector sealing washers **MUST** be replaced. **DO NOT** use the old sealing washers or double the sealing washers.

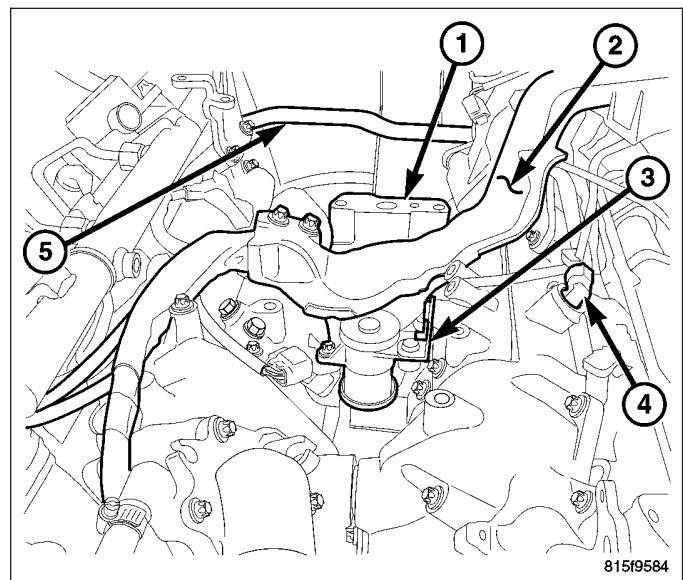
35. Lubricate the fuel injector body (1), install the left fuel injectors (1) and new lower sealing washers.
36. Install the injector retaining claws and tighten the bolts to 7 N·m plus 180 °(62 in. lbs. plus 180°).



37. Properly route and install the fuel return hoses (5) and connect them to the injectors.



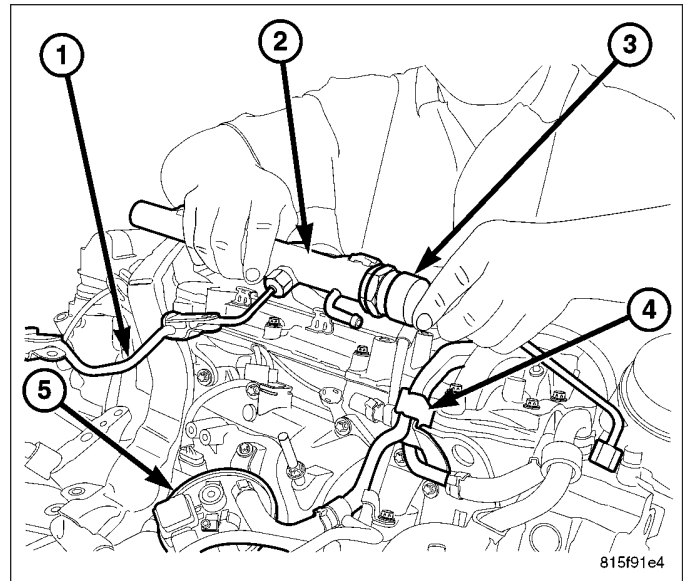
38. Properly route and connect the engine harness.



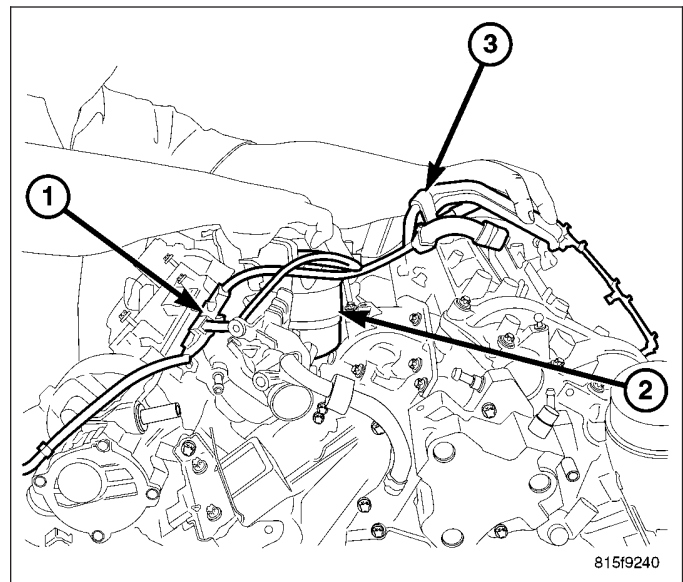
39. Install the fuel rail (2). Tighten the bolts to 33 N·m (24 ft. lbs.).

**CAUTION:** Inspect the fuel lines for wear or damage, look closely around the flange area. Replace as necessary. **DO NOT** over tighten.

40. Install the high pressure fuel lines, including the fuel rail equalizing line. Tighten the line nuts to 27 N·m (20 ft. lbs.)

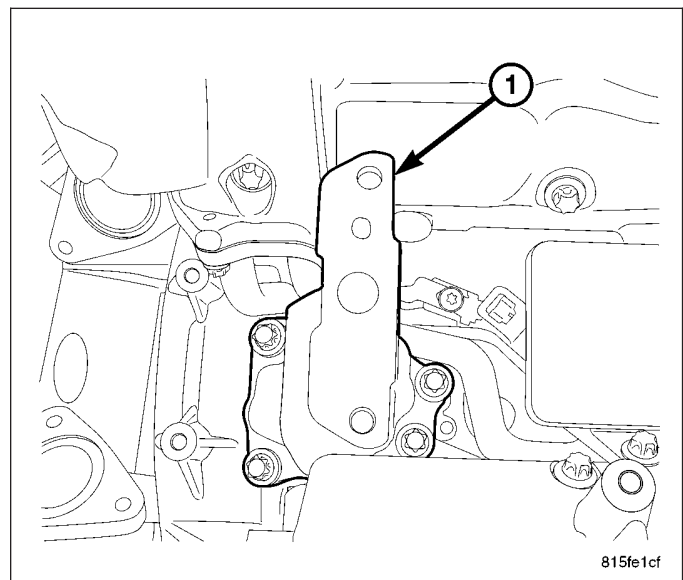


41. Install the fuel filter (2) and connect the harnesses (1) and hoses (3).



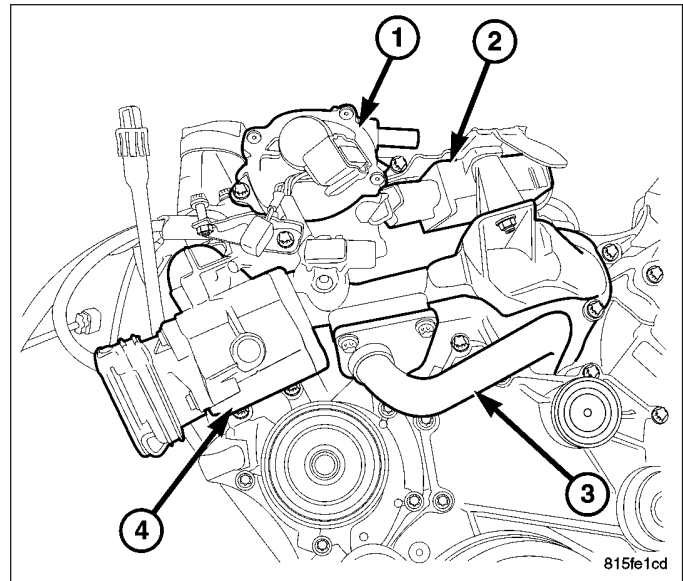
**CAUTION:** Care must be taken when installing the turbocharger oil housing adaptor (1). The gasket **MUST** be aligned properly with the oil housing passages or immediate damage to the turbocharger will occur.

42. Install the turbocharger oil housing adaptor (1) with the gasket tabs secured to the adaptor (1). Tighten bolts to 12 N·m (9 ft. lbs.).
43. Install the turbocharger (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - INSTALLATION).

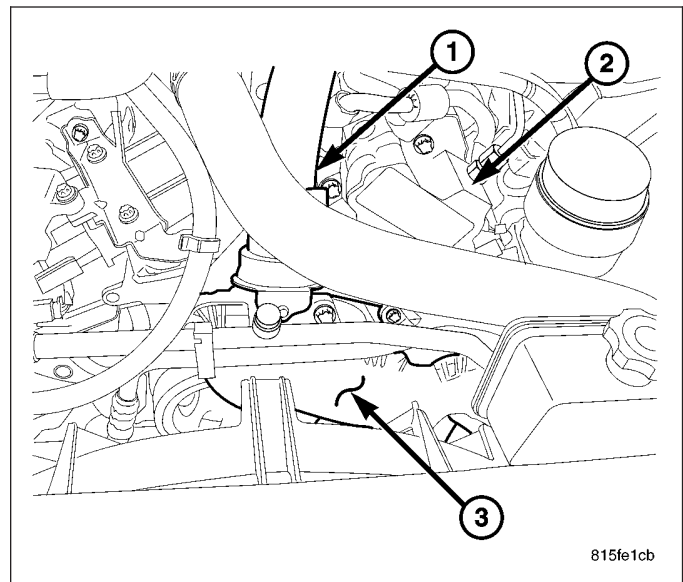




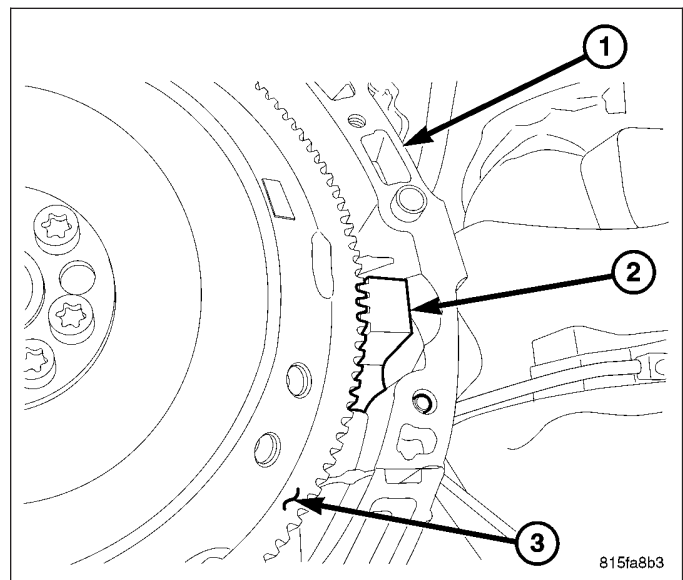
44. Install the air control valve and resonator.



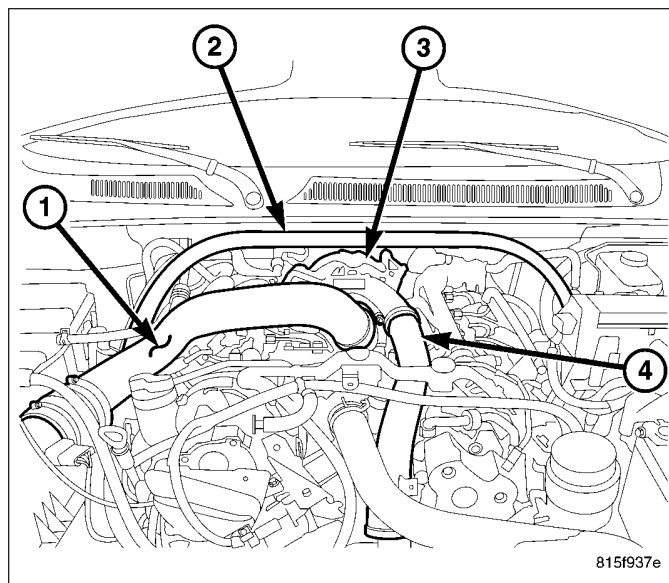
45. Install the charge air cooler inlet pipe and resonator.



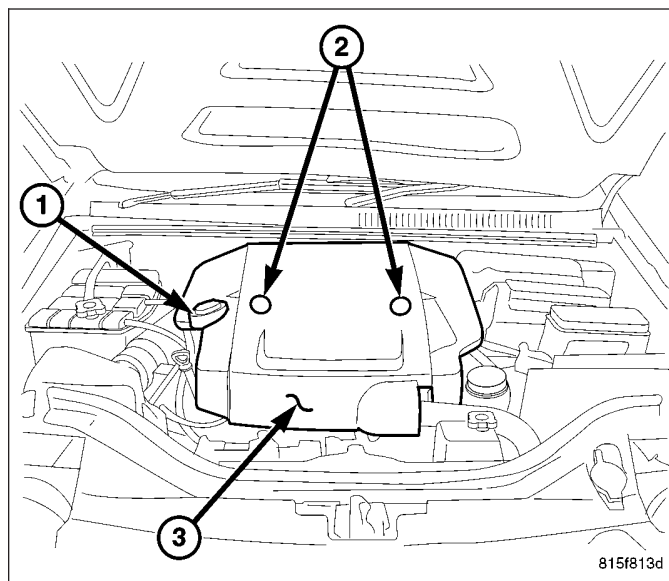
- 46. Install the cooling fan module.
- 47. Install the heater hose bracket and secure hoses.
- 48. Connect the vacuum pump supply hose.
- 49. Raise and support the vehicle.
- 50. Remove special tool #9102 crankshaft lock (2).
- 51. Install the starter blank.



- 52. Connect the cooling fan hydraulic lines.
- 53. Lower the vehicle.
- 54. Fill the cooling system.
- 55. Fill power steering system.
- 56. Install the strut tower support (2).
- 57. Connect the negative battery cable.



- 58. Start engine, allow to warm, turn engine off and inspect for leaks (Refer to 14 - FUEL SYSTEM - WARNING).
- 59. Purge the air from the power steering system using the scan tool.
- 60. Install the engine cover brackets and engine cover.



## RIGHT

**CAUTION:** Inspect and measure all cylinder head bolt lengths. If out of specification, replace as necessary (Refer to 9 - ENGINE/CYLINDER HEAD - STANDARD PROCEDURE).

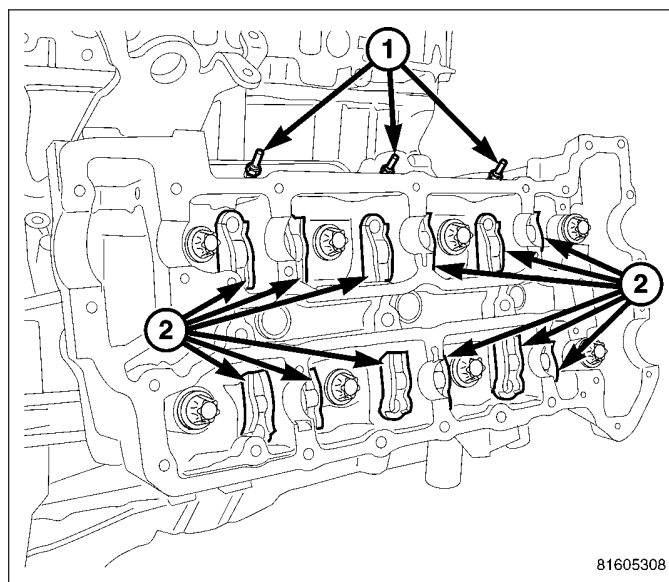
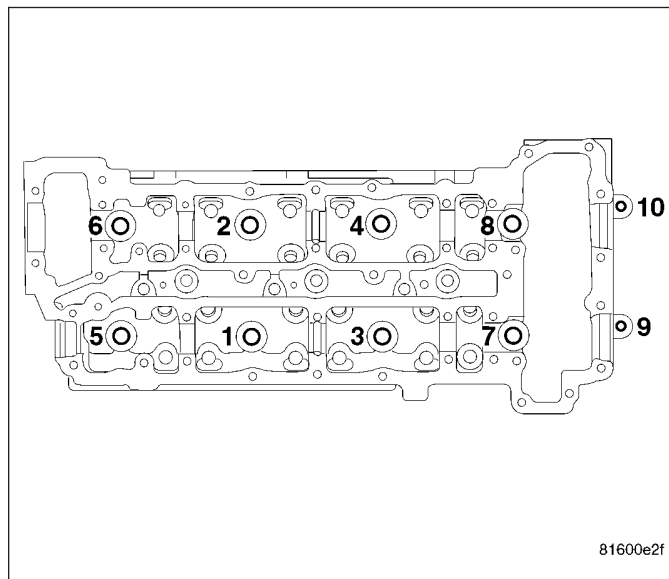
1. Clean and inspect gasket mating surfaces.
2. Position head gasket on engine block. Be sure the coolant passages align (part number should be facing up).
3. Place cylinder head on engine block.

**CAUTION:** Inspect and measure all cylinder head bolt lengths. If out of specification, replace as necessary (Refer to 9 - ENGINE/CYLINDER HEAD - STANDARD PROCEDURE). Do Not lubricate new cylinder head bolts. They already are coated with an anti scuff treatment.

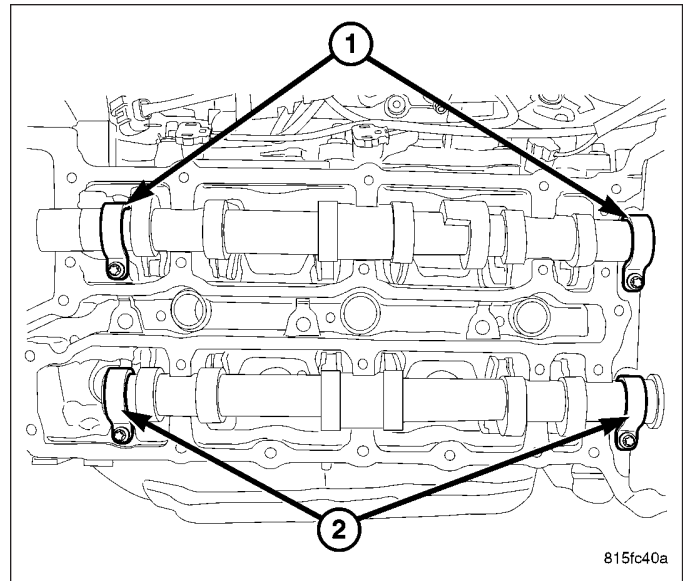
4. Tighten cylinder head bolts following procedure below.
  - a. Tighten M12 cylinder head bolts 1 through 8, in the sequence shown to 60 N·m (44 ft. lbs.).
  - b. Tighten bolts 9 and 10 to 20 N·m ( 177 in. lbs.).
  - c. Tighten 12 mm cylinder head bolts, 1 through 8, in sequence shown, an additional 90 degrees.
  - d. Recheck and tighten M8 bolts 9 and 10 to 20 N·m ( 177 in. lbs.).
  - e. And then again, tighten M12 cylinder head bolts, 1 through 8, in sequence an additional 90 degrees.

**NOTE:** Followers and tappets assemblies must be installed in same location as removed.

5. Install the followers (2) and tappets (2) into their original positions.
6. Install the glow plugs (1). Tighten glow plugs to 12.5 N·m (100 in. lbs.).

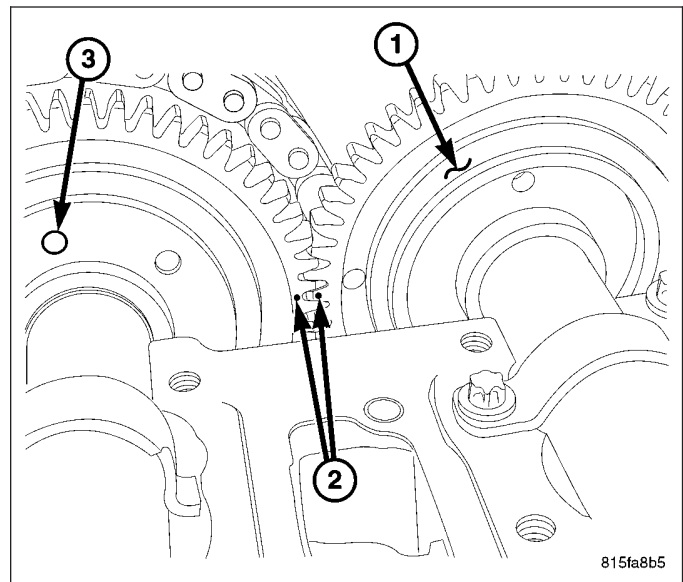


7. Install the right exhaust camshaft. Tighten the retaining fasteners to 8 N·m (71 in. lbs.).
8. Install the right intake camshaft. Tighten the retaining fasteners to 8 N·m (71 in. lbs.).

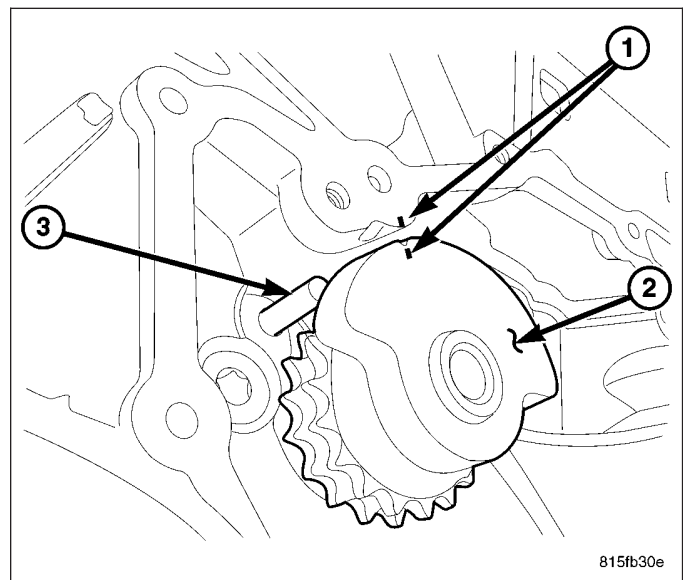


**NOTE:** Care must be taken to assure the proper exhaust camshaft to intake camshaft alignment.

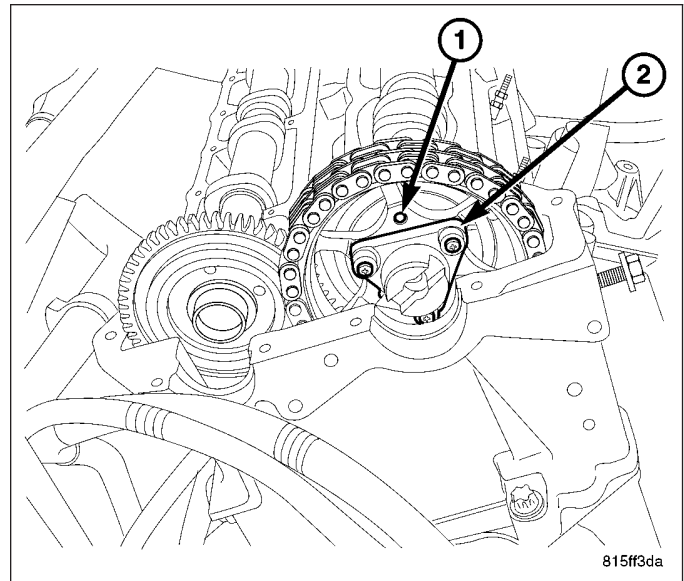
9. Align the camshaft marks so the alignment marks are facing each other.
10. Insert the timing chain, through the cylinder head, and on to the camshaft drive gear.



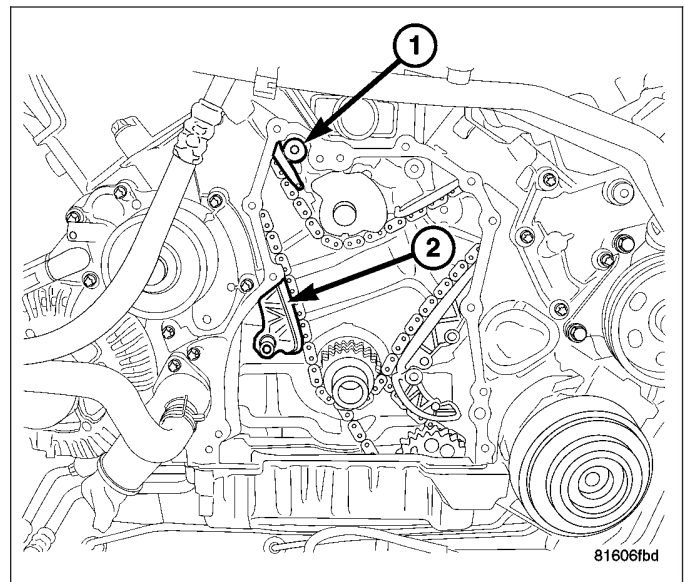
11. Align the balance shaft with the scribe or paint mark.
12. Once the camshaft drive gear is mated with the timing chain, install the camshaft drive gear on to the camshaft and assure the balance shaft is aligned properly.



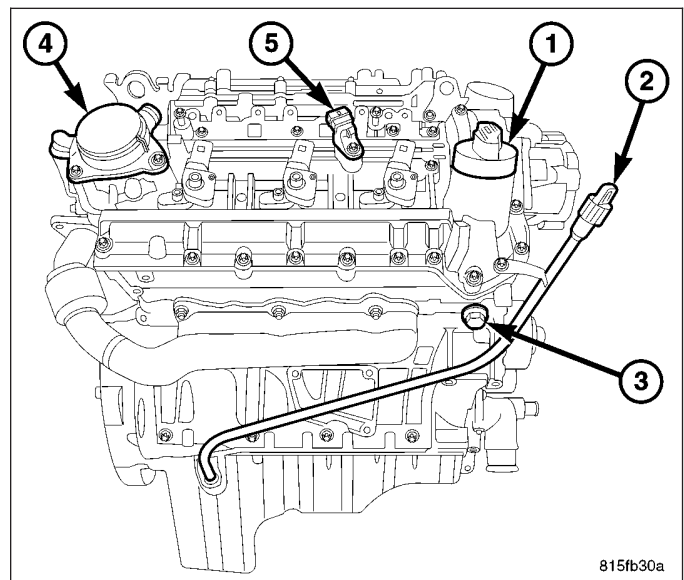
13. Install the upper two of the three camshaft drive gear bolts.



14. Install the right lower timing chain guide (2), seat the guide pin at the top, and tighten the guide bolt to 12 N·m (9 ft. lbs.).
15. Install the right upper timing chain guide (1), seat the guide pin at the top, and tighten the guide bolt to 12N·m (9 ft. lbs.).



16. Install the timing chain tensioner (3).



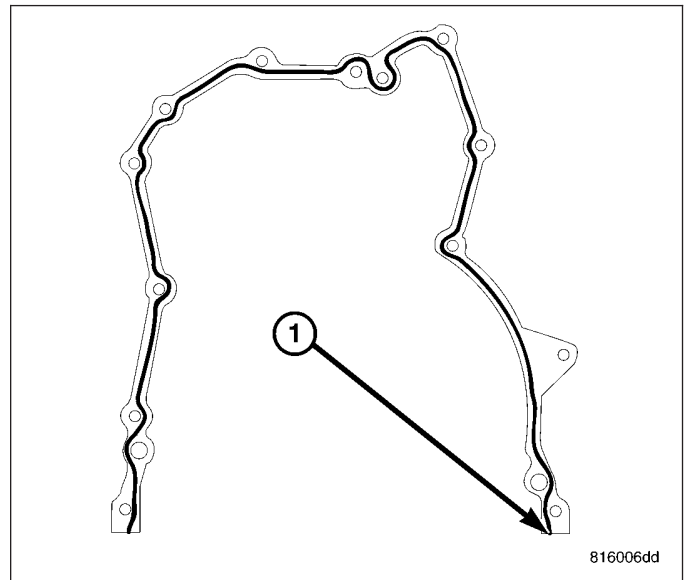
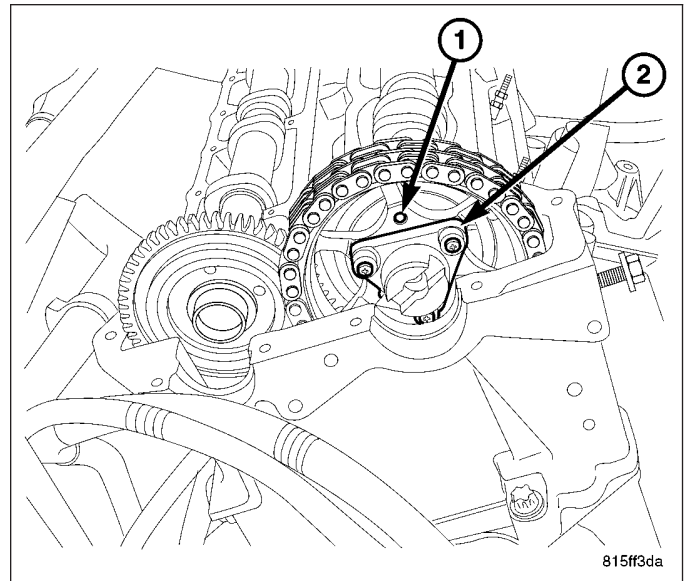
17. Rotate the engine by the vibration damper bolt enough to gain access to the third camshaft bolt hole.
18. Install the third camshaft drive gear retaining bolt and tighten the bolt to 18 N·m (13 ft. lbs.).

**WARNING:** If the camshaft, balance shaft and or crankshaft alignment marks are not aligned properly, immediate damage to the engine will occur. If the camshafts, balance shaft and or crankshaft do not align properly after rotating the engine to the original starting point, STOP and begin the alignment procedure again.

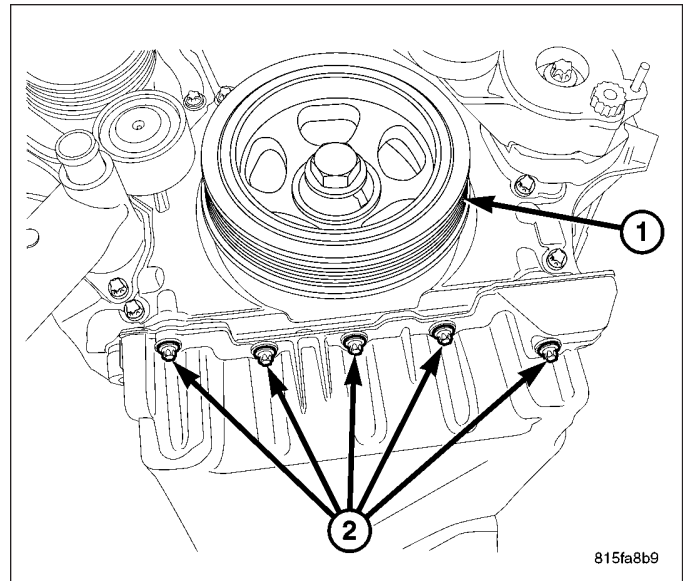
19. Rotate the engine back to TDC by the vibration damper bolt until the crankshaft, camshaft and balance shaft align TDC again.
20. Tighten the two remaining camshaft drive gear bolts to 18 N·m (13 ft. lbs.).

**WARNING:** Check that all the timing chain fits properly on all the timing gears. Failure to do so will result in immediate engine damage.

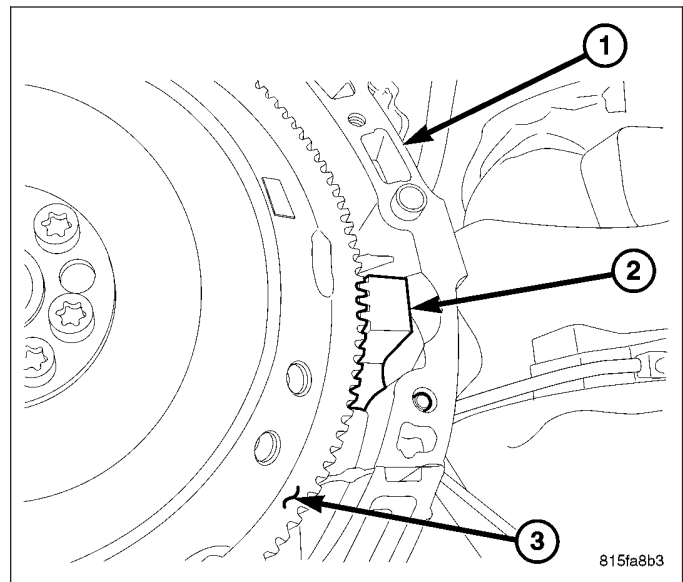
21. Add a 1.5 mm continuous bead of Mopar Engine Sealant RTV (1) to the timing chain cover and the front portion of the oil pan, then install the timing chain cover. Tighten the bolts to 8.5 N·m (74 in. lbs.).
22. Raise and support the vehicle.



23. Install the 5 front oil pan (2) to timing cover bolts. Tighten the bolts to 20 N·m (177 in. lbs.).

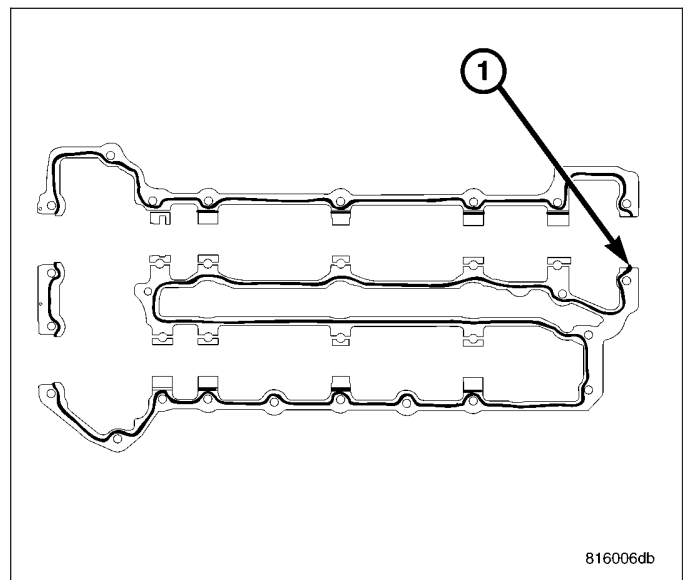


24. Install special tool # 9102 crankshaft lock (2).  
25. Lower the vehicle.  
26. Install the vibration damper. Tighten the bolts to 200 N·m (148 ft. lbs.). and then an additional 90°.



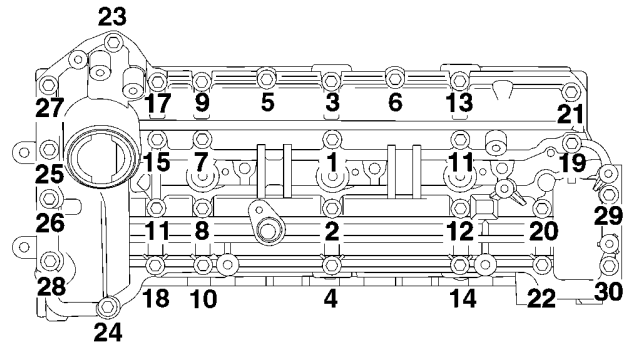
**NOTE:** Care must be taken not to get any engine sealer on the camshaft journals.

27. Add a 1.5 mm continuous bead of Mopar Engine Sealant RTV (1) to the cylinder head cover, then install the right cylinder head cover along with a new camshaft seal.



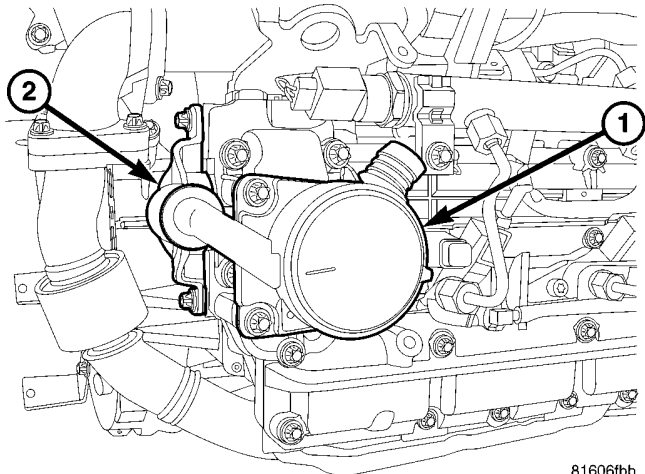


28. Tighten the bolts in three stages following the sequence provided. First to 4 N·m (35 in. lbs.), then to 6 N·M (53 in. lbs.) and then to 8.5 N·m (75 in. lbs.).



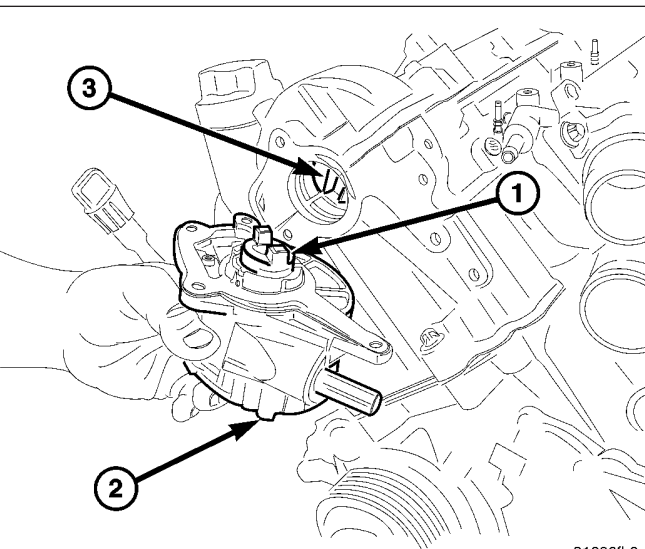
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29. Install the oil separator (1) and housing adaptor (2) with new camshaft seal. Tighten the bolts to 11 N·m (97 in. lbs.).



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30. Align the pump drive gear (1) with the camshaft drive gear (3) and install the vacuum pump (2) with new gasket. Tighten bolts to 9 N·m (7 ft. lbs.).

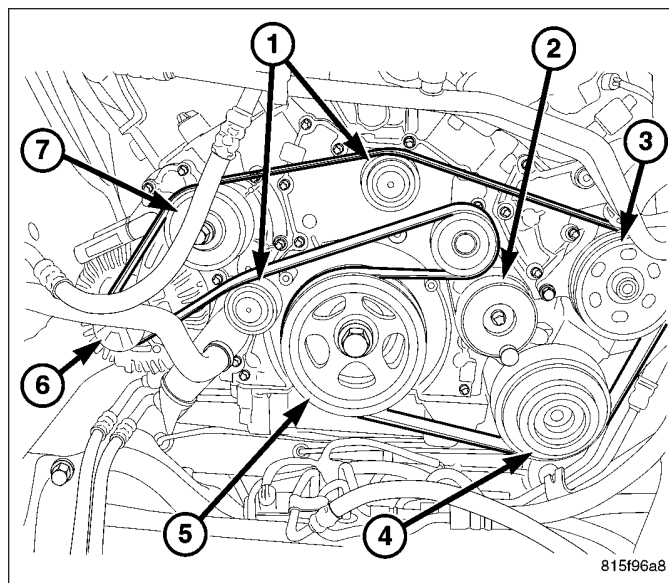


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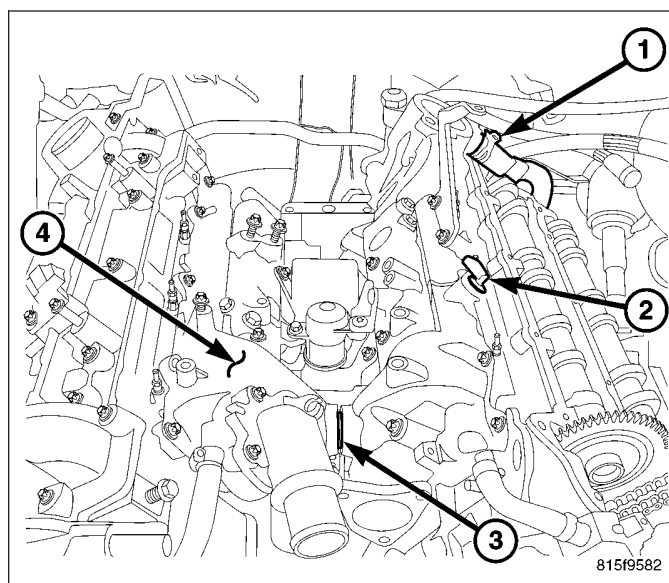
**NOTE:** Idler pulley bolts are L.H. thread.

31. Install the belt idler pulleys (1) Tighten the bolts to 58 N·m (43 ft. lbs.).
32. Install the accessory drive belt tensioner (2). Tighten the bolts to 58 N·m (43 ft. lbs.).
33. Install the accessory drive belt.



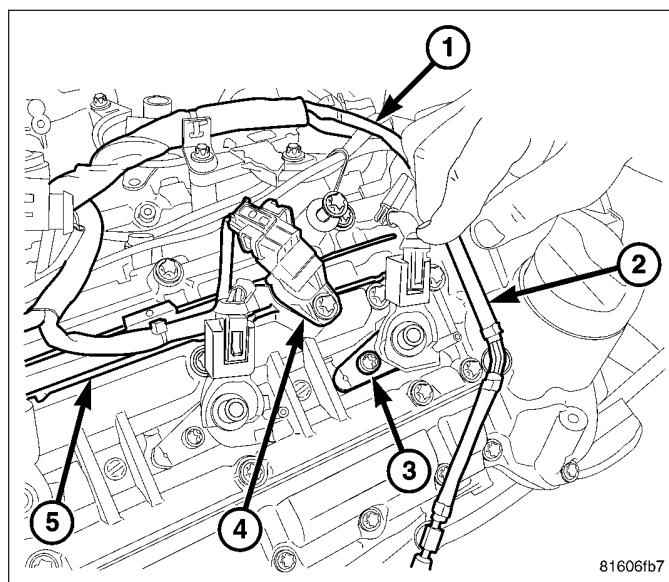
**CAUTION:** The right intake manifold upper thermostat housing bolts should be tightened to 8.5 N·m (74 in. lbs.).

34. Install the intake manifold (4). Tighten bolts to 16 N·m (142 in. lbs.), starting in the middle and tightening in a cross pattern outward until reaching the upper thermostat bolts on the right front manifold.
35. Tighten the upper thermostat bolts on the right cylinder head to 8.5 N·m (74 in. lbs.).



**CAUTION:** The fuel injector sealing washers **MUST** be replaced. **DO NOT** use the old sealing washers or double the sealing washers. **DO NOT** apply injector body lubricant near the injector nozzles.

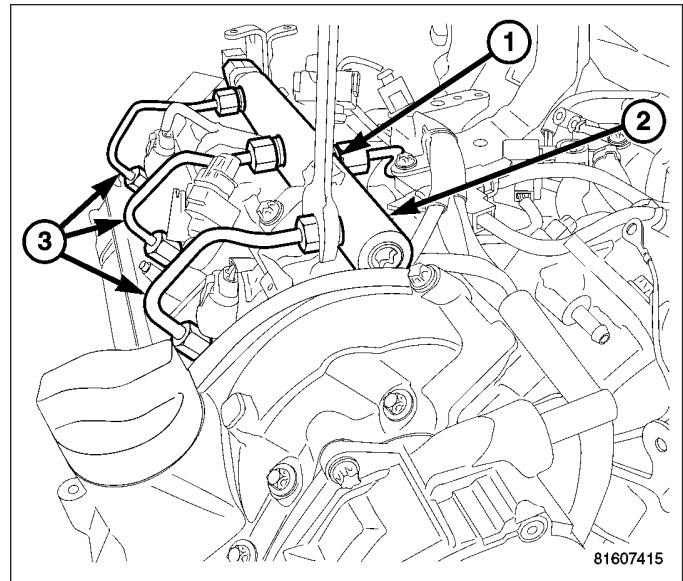
36. Lubricate the fuel injector body, install the right fuel injectors and new sealing washers.
37. Install the injector retaining claws (3) and tighten the bolts to 7 N·m, plus 180° (62 in. lbs., plus 180°).
38. Properly route and install the fuel return hoses (2) and connect them to the injectors.
39. Properly route and connect the engine harness (1).



40. Install the fuel rail (2). Tighten the bolts to 27 N·m (20 ft. lbs.).

**CAUTION:** Inspect the fuel lines for wear or damage, look closely around the flange area. Replace as necessary. **DO NOT** over tighten.

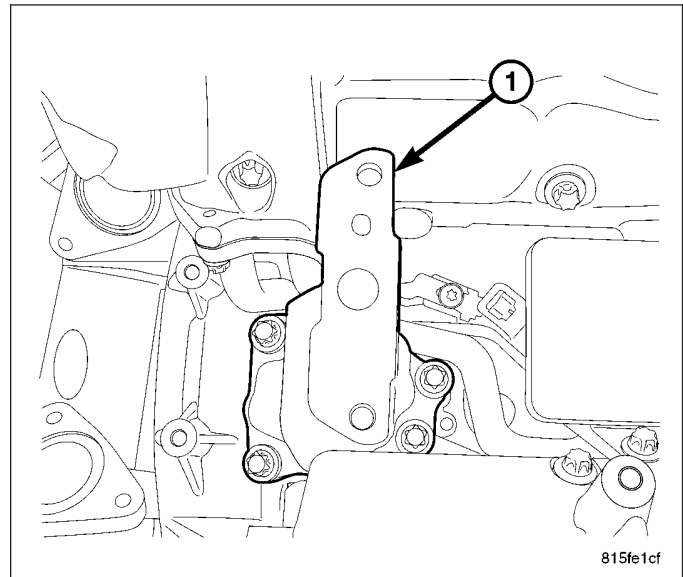
41. Install the high pressure fuel lines (3), including the fuel rail transfer line (1). Tighten the line nuts to 33 N·m (24 ft. lbs.).



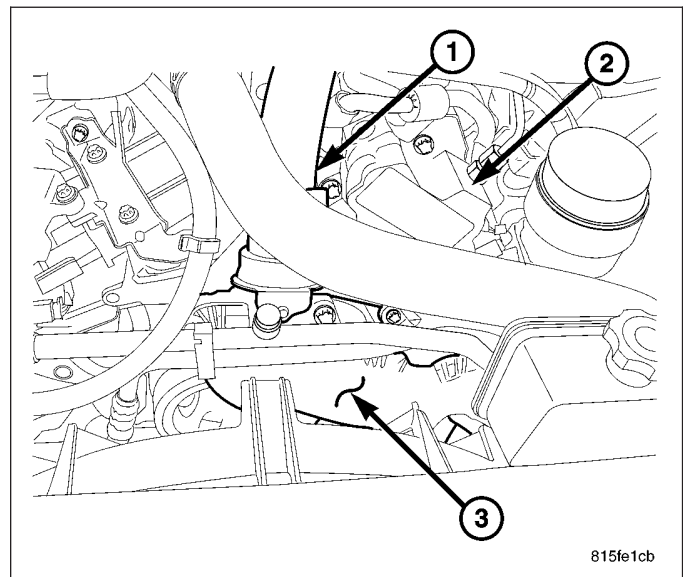
42. Install the fuel filter and connect the harnesses and hoses using Fuel Line Pliers 9539 Hose Clamp pliers.

**CAUTION:** Care must be taken when installing the turbocharger oil housing adaptor. The gasket **MUST** be aligned properly with the oil housing passages or immediate damage to the turbocharger will occur.

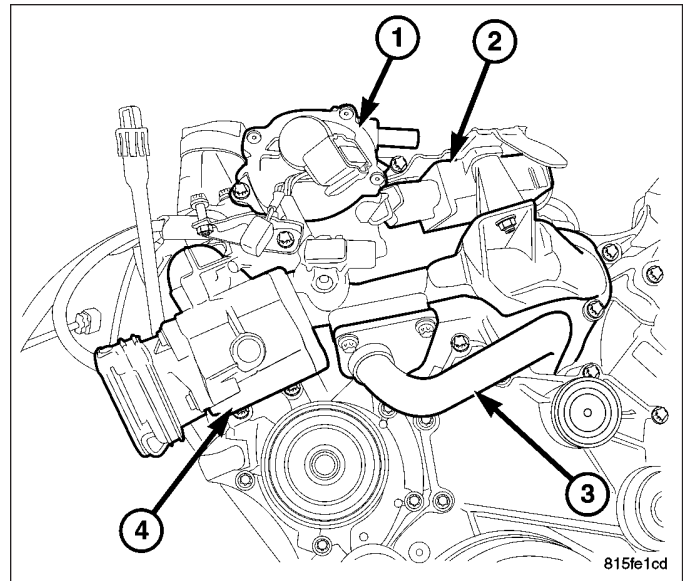
43. Install the turbocharger oil housing adaptor with the gasket tabs secured to the adaptor. Tighten bolts to 12 N·m (9 ft. lbs.).
44. Install the turbocharger (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - INSTALLATION).



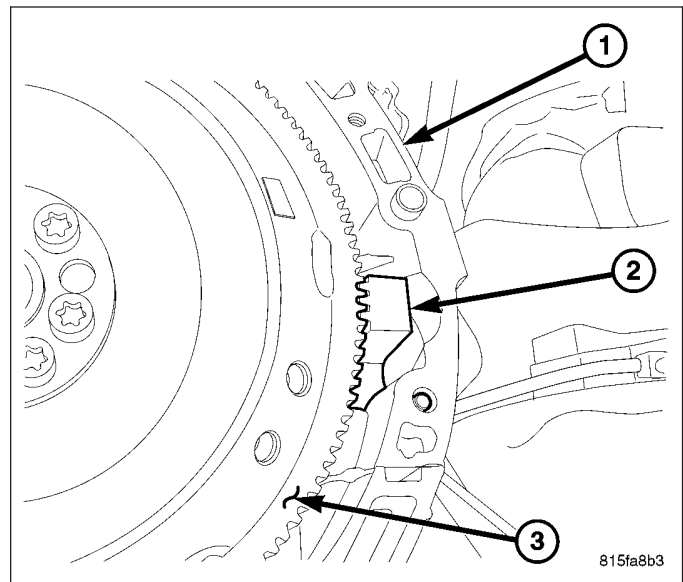
45. Install the charge air inlet pipe (1) and resonator (3).



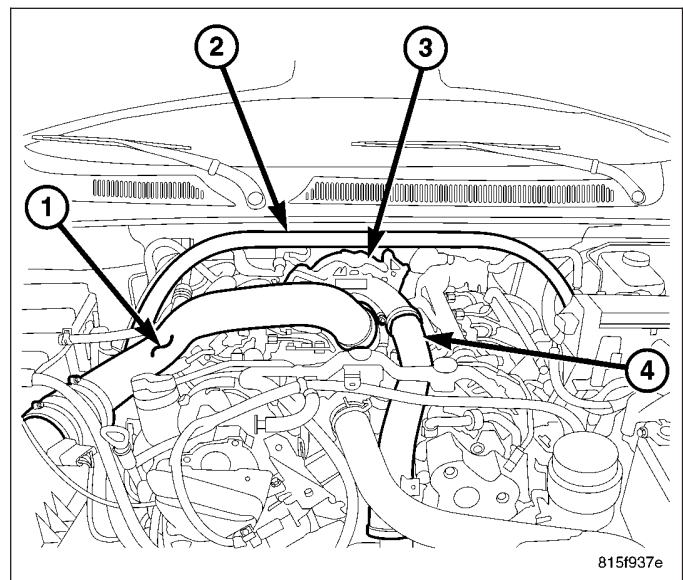
46. Install the air control valve and resonator (4).



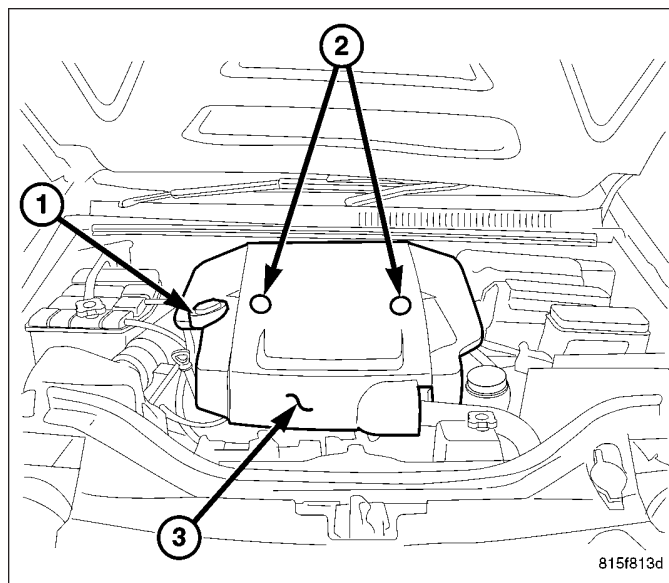
- 47. Install the cooling fan module.
- 48. Connect the vacuum pump supply hose.
- 49. Raise and support the vehicle.
- 50. Remove special tool #9102 crankshaft lock (2).
- 51. Install the starter blank.
- 52. Connect the cooling fan hydraulic lines.
- 53. Lower the vehicle.
- 54. Fill the cooling system.
- 55. Fill power steering system.



- 56. Install the strut tower support (2).
- 57. Connect the negative battery cable.
- 58. Start engine, allow to warm, turn engine off and inspect for leaks (Refer to 14 - FUEL SYSTEM - WARNING).
- 59. Purge the air from the power steering system using the scan tool.



60. Install the engine cover brackets and engine cover (3).

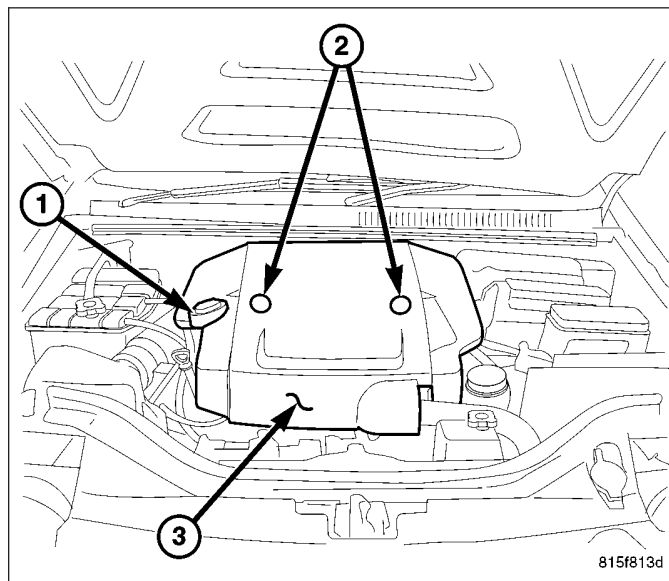


## SEAL(S)-CAMSHAFT OIL

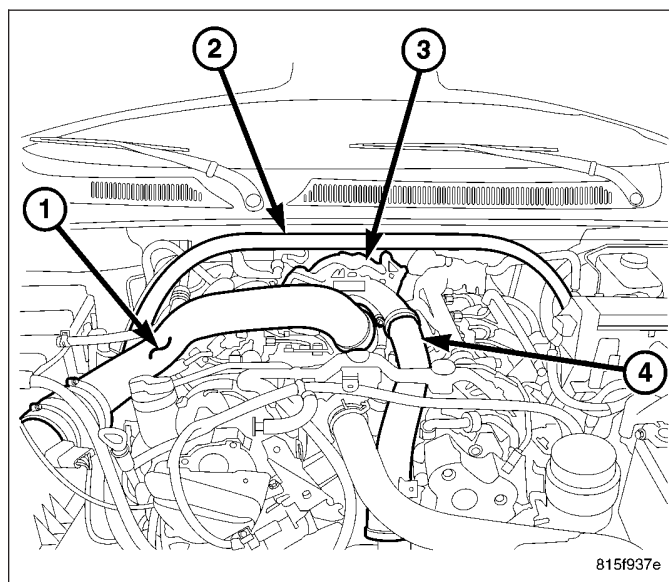
### REMOVAL

#### LEFT

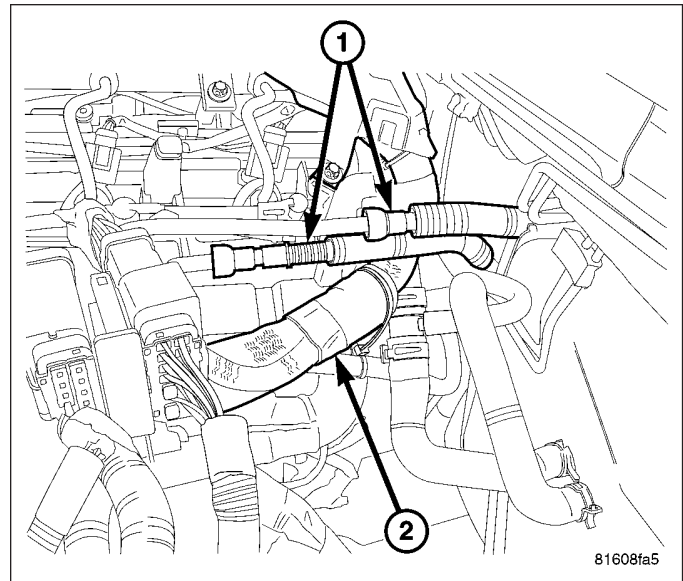
1. Disconnect negative battery cable.
2. Remove the engine cover (3) and bracket.



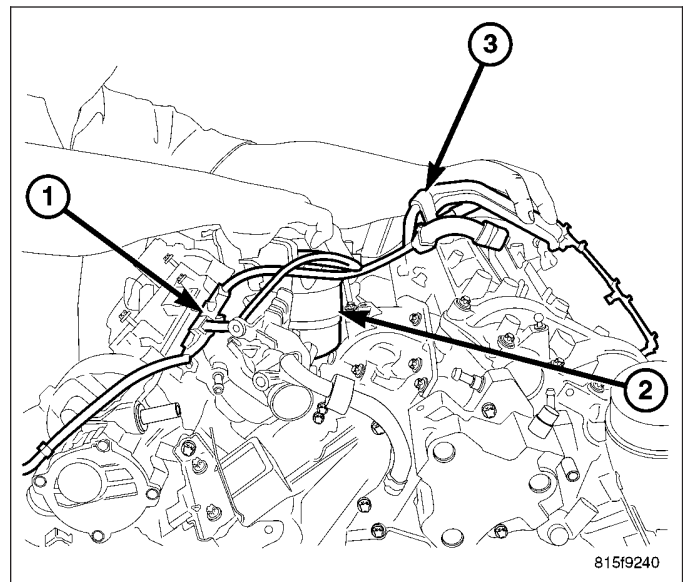
3. Remove the strut tower support (2).



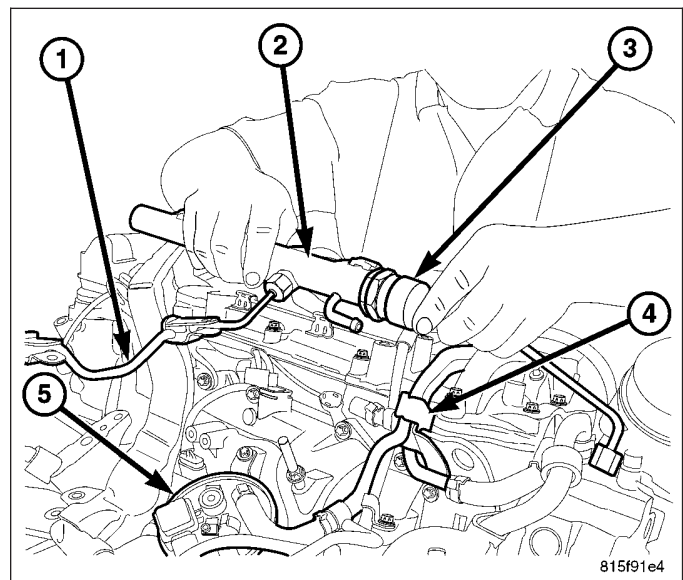
4. Disconnect the fuel tank supply (1) and return lines (1) from the fuel line bundle.
5. Separate the rear engine wiring harness (2) and hold downs at cylinder head cover.



6. Separate the fuel supply line at the high pressure pump and fuel filter.
7. Remove the high pressure fuel line from the high pressure pump to the fuel rail.

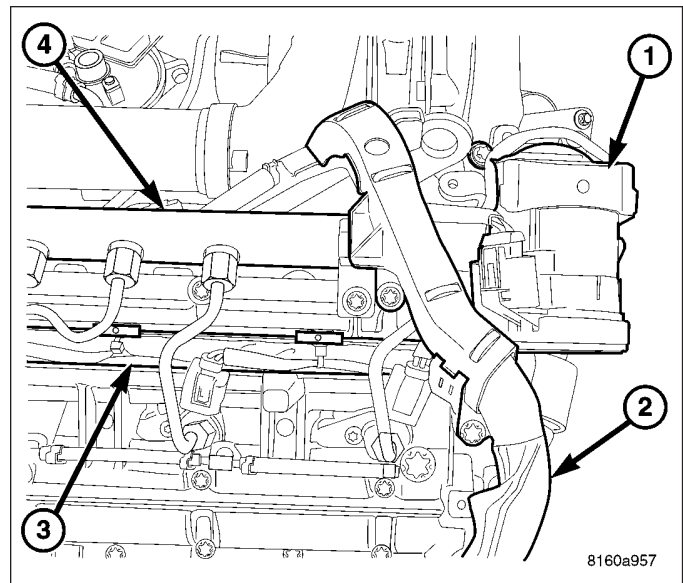


8. Remove the high pressure lines from the fuel rail to fuel injectors.
9. Disconnect the fuel injector electrical connectors.
10. Remove the oil filter housing to engine cover bracket.
11. Lift up on the center of the return fuel line connector and separate the return fuel hose from fuel injectors.
12. Remove the fuel rail (2).





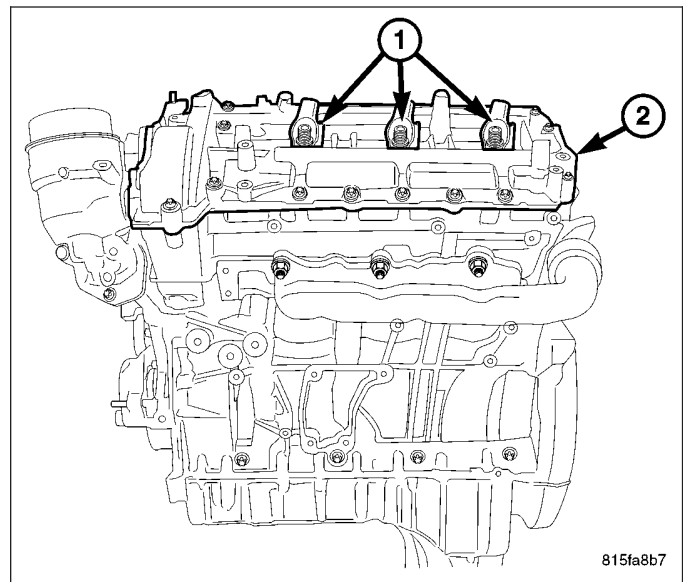
13. Remove the engine harness retainers and fasteners (2).
14. Remove the EGR valve (1).



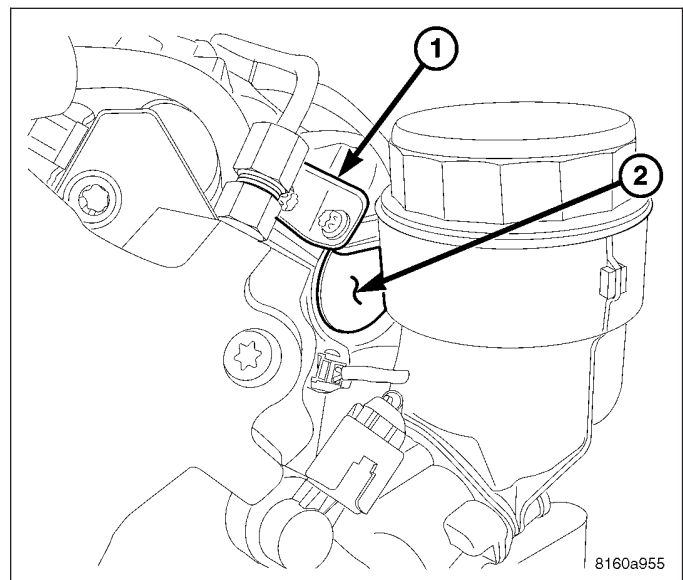
15. Remove the fuel injectors (1).
16. Remove the power brake booster hose and set aside.
17. Remove the cylinder head cover (2) fasteners, note the different size fasteners for assembly.

**CAUTION:** Care must be taken not to damage the cylinder head cover. If the sealant is difficult to separate, use a hand held heat gun and warm the area thoroughly along the sealer bead.

18. Remove the cylinder head cover (2).

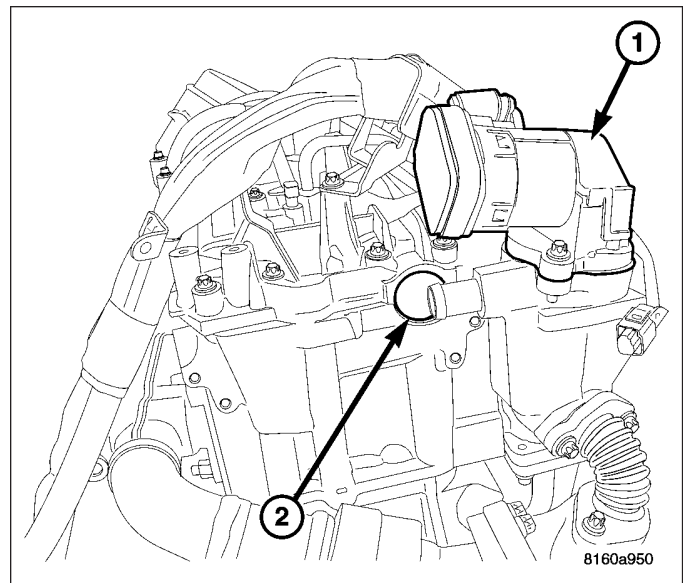


19. Remove the front camshaft oil seal (2).



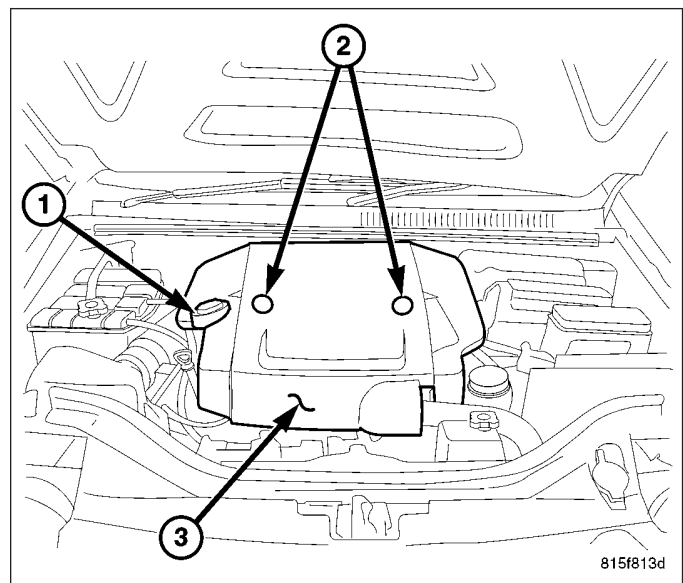


20. Remove the left rear camshaft oil seal (2).

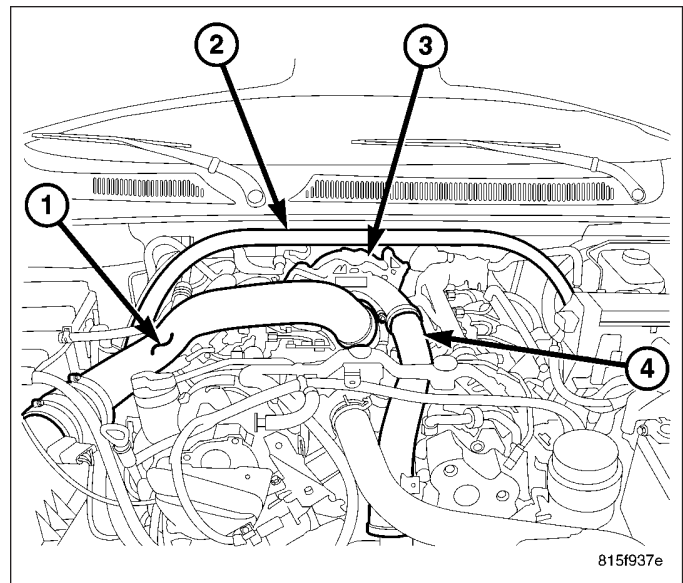


## RIGHT

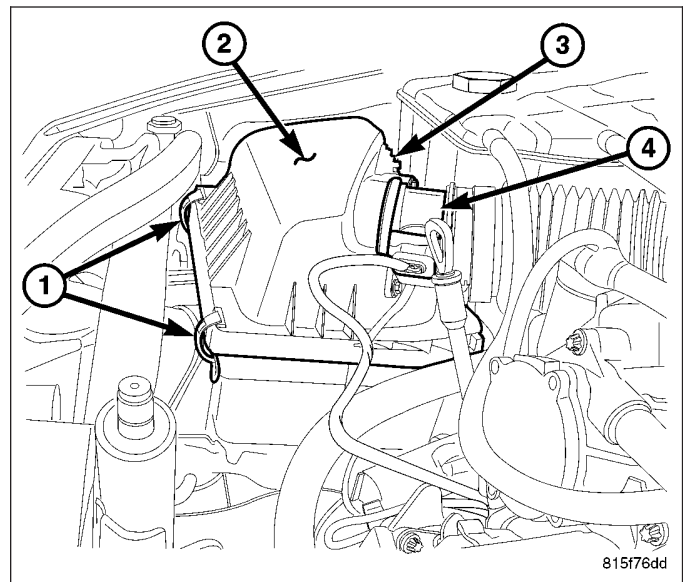
1. Disconnect the negative battery cable.
2. Remove the engine cover (3).



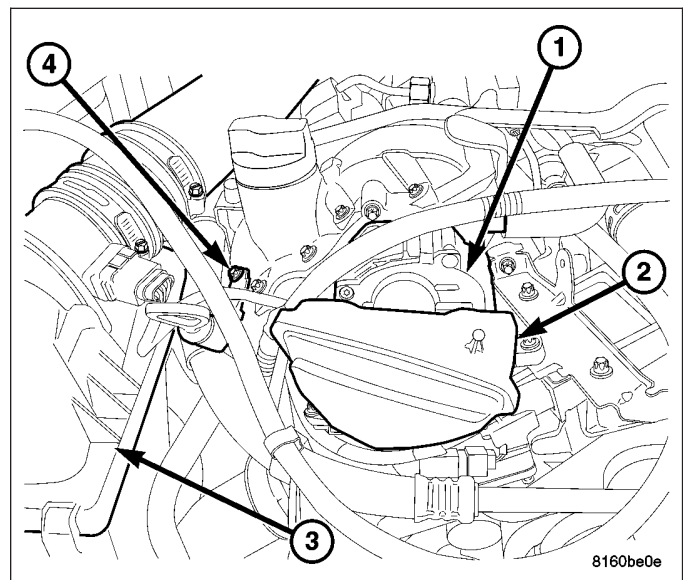
3. Remove the strut tower support (2).



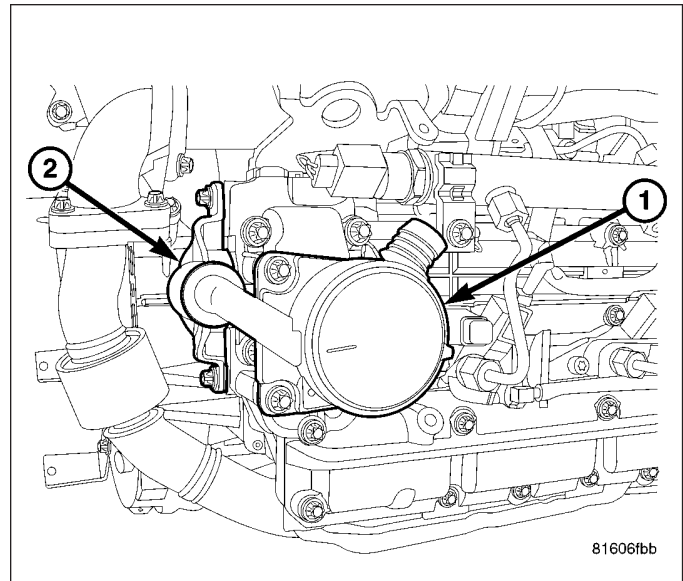
4. Remove the air inlet tube to the turbocharger along with the air cleaner cover (2).



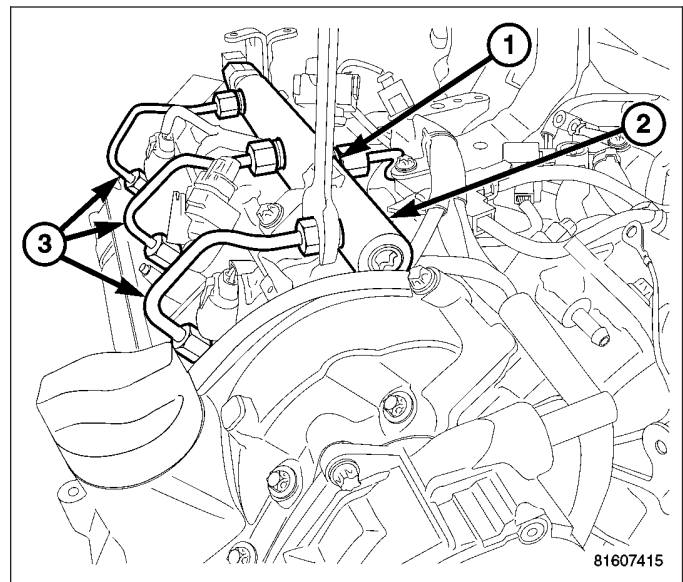
5. Remove the air control valve resonator (2).
6. Remove the vacuum pump (1).
7. Remove the oil level indicator fastener (4).



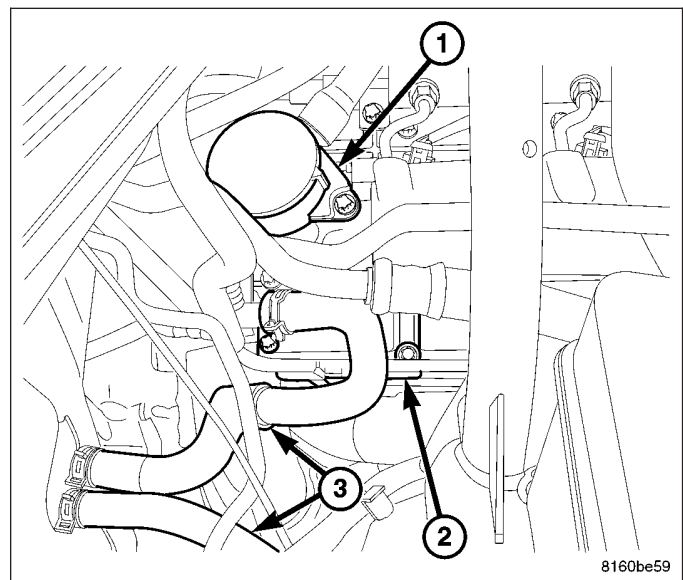
8. Remove the oil separator (1) and rear housing adaptor (2).



9. Remove the injector cover.  
10. Remove the fuel rail (2).  
11. Remove the high pressure fuel lines at the injectors (3).  
12. Disconnect the return fuel hose from the injectors.  
13. Disconnect the fuel injector and camshaft position sensor wiring harness connectors and set aside.  
14. Remove the injectors.



15. Disconnect the heater hose bracket from the cylinder head cover.

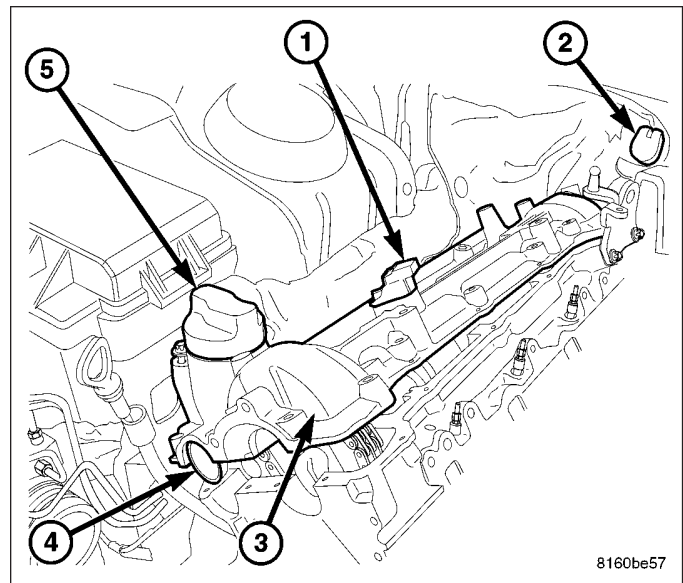


16. Disconnect the vacuum pump supply hose pipe at the front of the cylinder head cover.
17. Remove the transmission tube (2) fastener at the engine cover bracket.

**CAUTION:** Care must be taken not to damage the cylinder head cover. If the sealant is difficult to separate, use a hand held heat gun and warm the area thoroughly along the sealer bead.

**NOTE:** The rear camshaft seal is located inside the oil separator housing adaptor assembly.

18. Remove the cylinder head cover (3) and front seal (4).



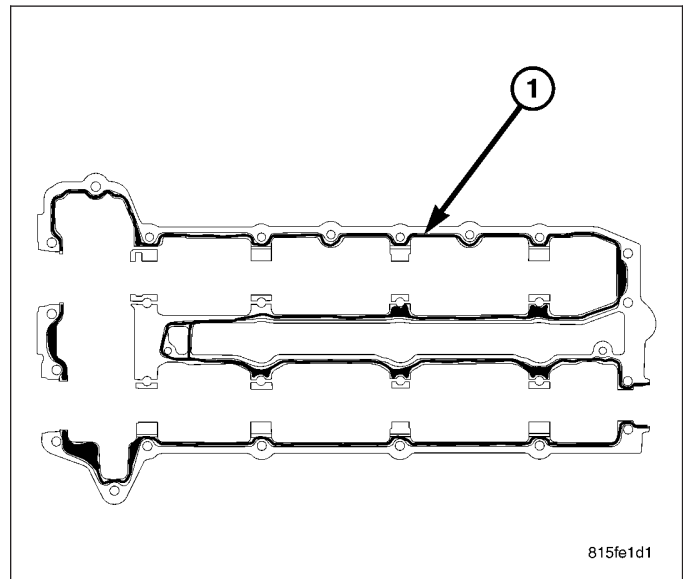
## INSTALLATION

### LEFT

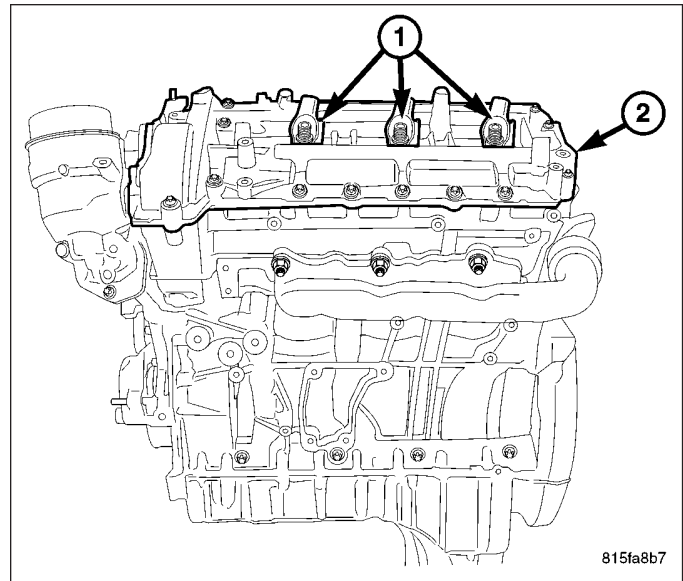
1. Clean all mating surfaces.

**NOTE:** Care must be taken not to get any engine sealer on the camshaft journals.

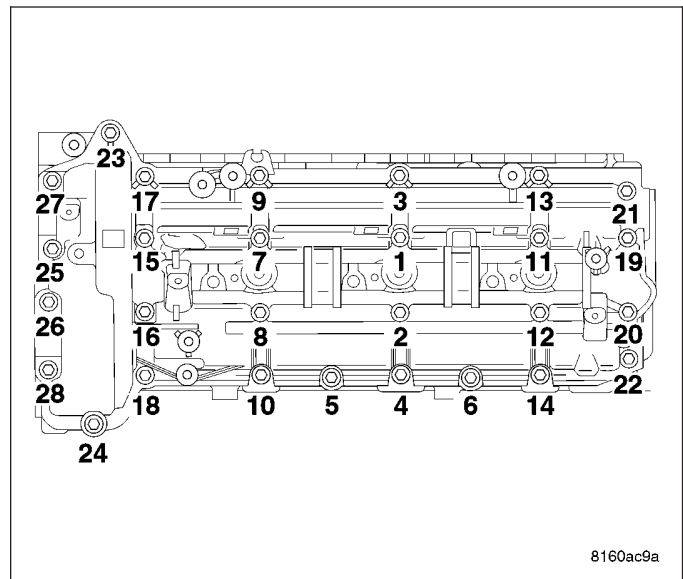
2. Add a 1.5 mm bead of Mopar Sealant (1) to the cylinder head cover.



3. Place the camshaft seals into position within the cylinder head.
4. Install the cylinder head cover.



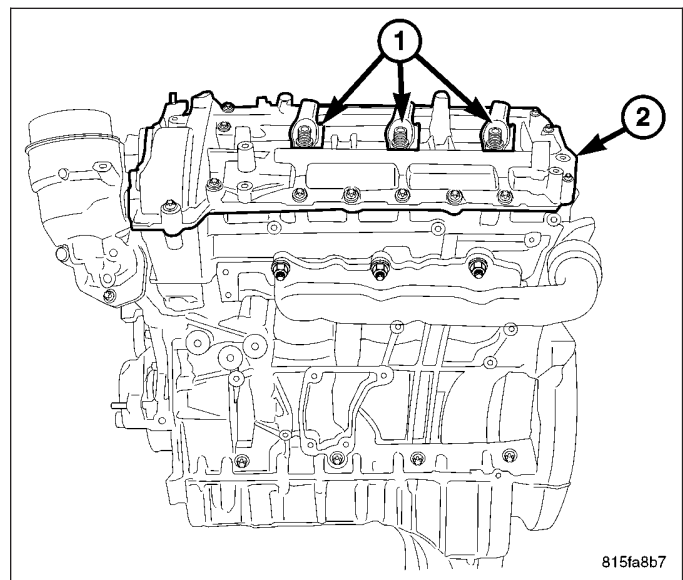
5. Tighten the bolts in three stages following the sequence provided. First to 4 N·M (35 in. lbs.), then to 6 N·M (53 in. lbs.), and then to 8.4 N·M (75 in. lbs.).



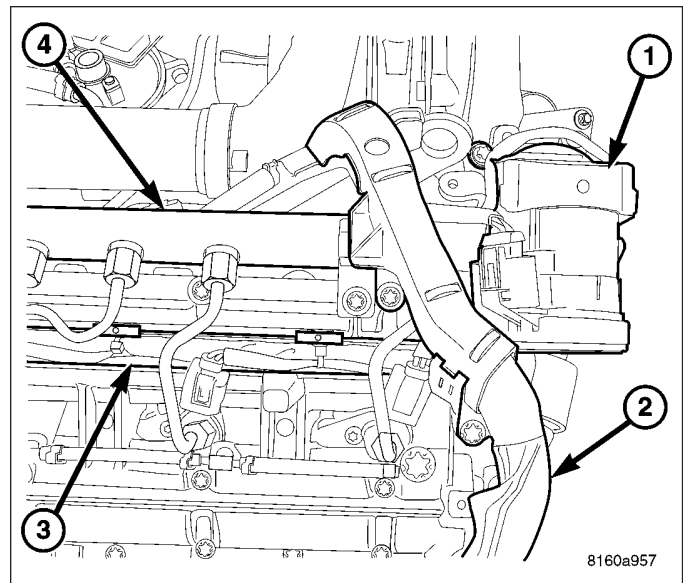
**CAUTION:** The fuel injector sealing washers **MUST** be replaced. **DO NOT** use the old sealing washers or double the sealing washers.

**NOTE:** Care must be taken not to apply any lubricant to the fuel injector nozzles.

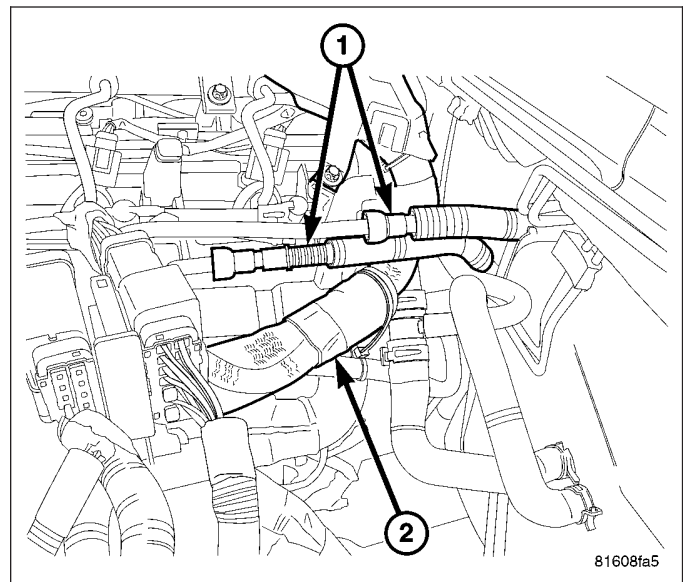
6. Lubricate the fuel injector bodies and install the fuel injectors (1). Install the injector retaining claws and tighten the bolts to 7 N·m plus 180 °(62 in. lbs. plus 180°).



7. Install the EGR valve (1).
8. Install the engine harness fasteners (2), route the return fuel hose, and injector harness.
9. Install the fuel rail (4) and high pressure lines.
10. Install the left rear engine cover bracket.
11. Connect the injector electrical connectors and return fuel hoses.



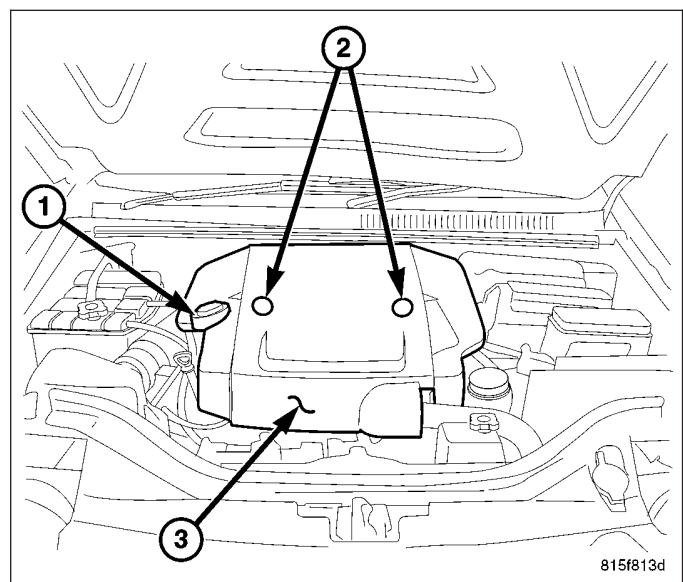
12. Install the high pressure fuel line from the high pressure pump to the fuel rail.
13. Install the fuel supply pipe bundle, reclamp at the high pressure pump and fuel filter.
14. Connect the fuel tank supply and return hoses (1) at fuel pipe bundle.



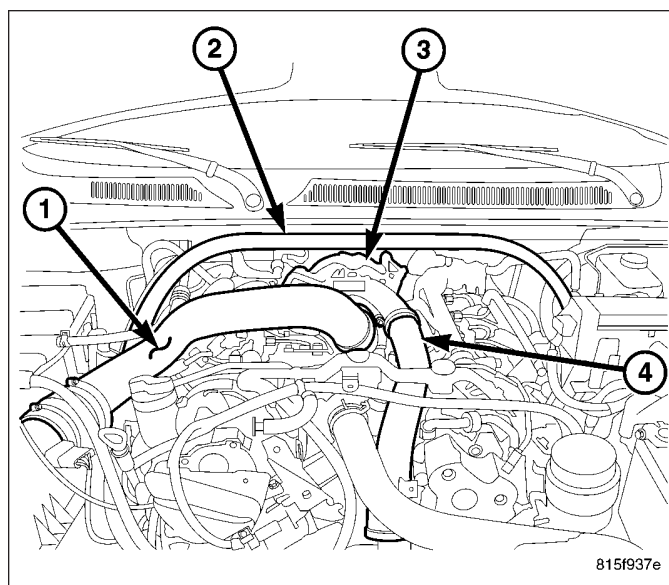
15. Install the engine cover (3) and bracket.
16. Connect the negative battery cable.

**NOTE: (Refer to 14 - FUEL SYSTEM - WARNING).**

17. Start engine, allow to warm, turn engine off and inspect for leaks.



18. Install the strut tower support (2).

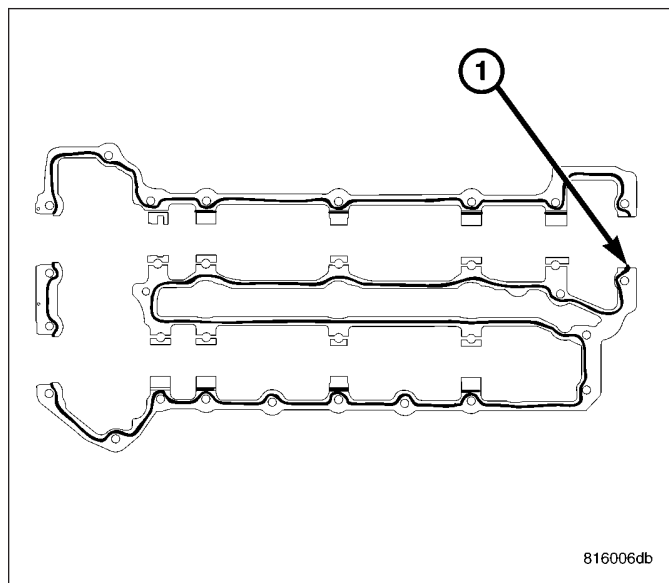


## RIGHT

1. Clean all mating surfaces.

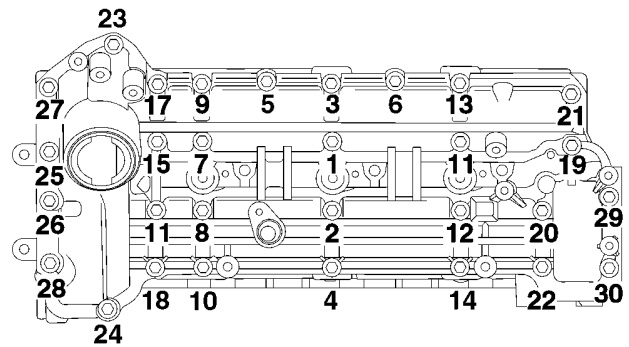
**NOTE:** Care must be taken not to get any engine sealer on the camshaft journals.

2. Apply a 1.5MM bead of Mopar<sup>®</sup> Engine RTV Sealant (1) to the cylinder head cover.



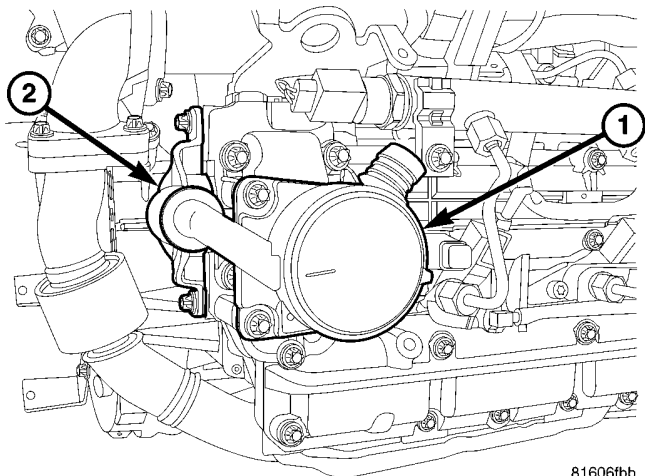


3. Place the camshaft seal into position.
4. Install the cylinder head cover. Tighten the bolts in three stages following the sequence provided. First to 4 N·M (35 in. lbs.), then to 6 N·M (53 in. lbs.), and then to 8.4 N·M (75 in. lbs.).



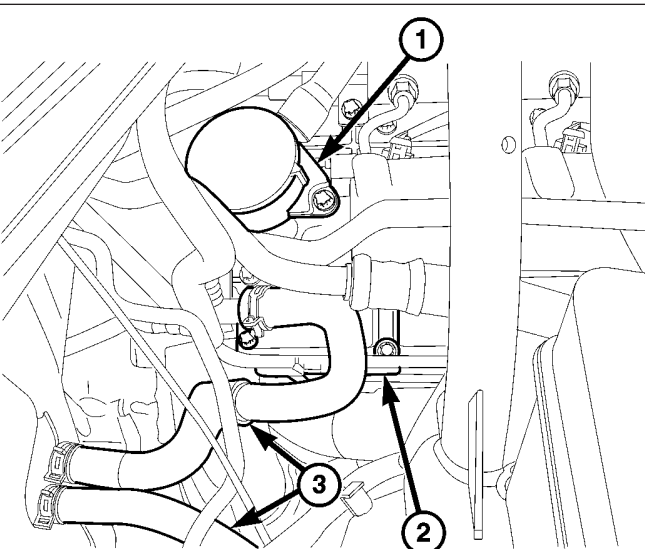
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5. Install the oil separator housing adaptor (2) with new camshaft seal. Tighten fasteners to 9 N·m (7 ft. lbs.).
6. Install the oil separator (1). Tighten fasteners to 9 N·m (7 ft. lbs.).



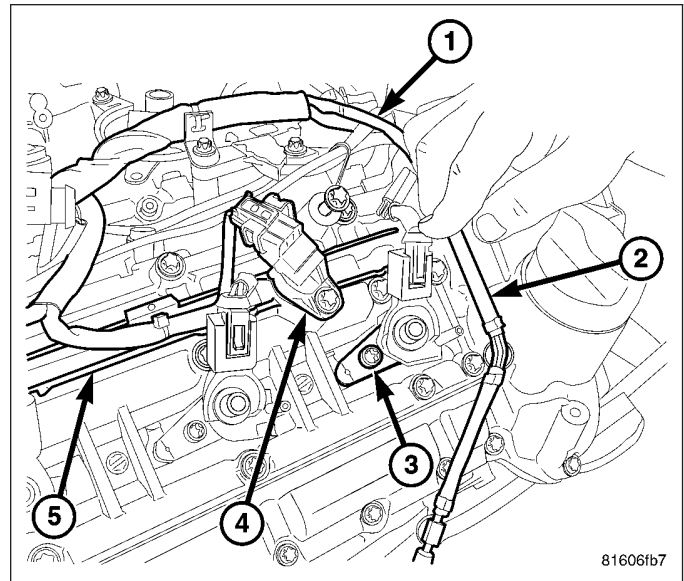
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7. Secure the transmission tube fastener to the engine cover bracket.
8. Secure the heater hose bracket (2) to the cylinder head cover.

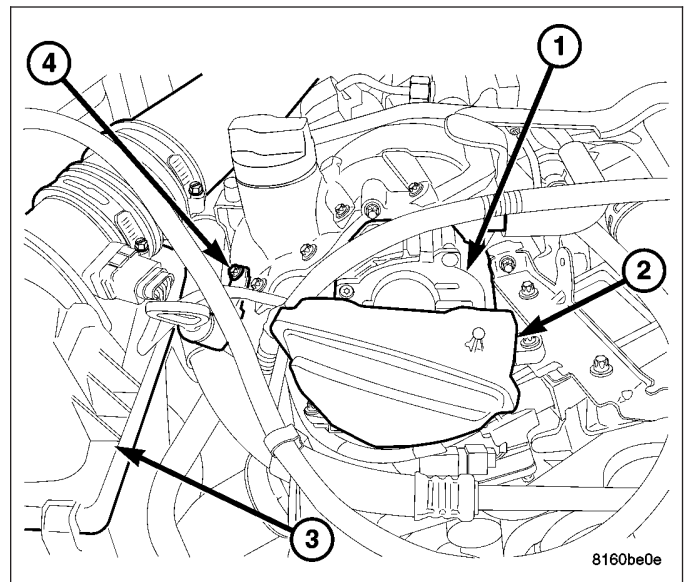


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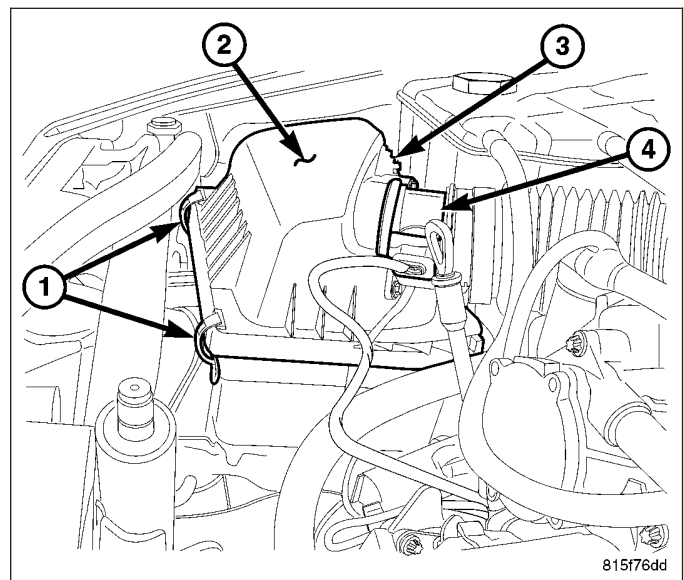
9. Secure the vacuum pump hose pipe to the cylinder head cover.
10. Install the fuel injectors. Tighten hold down fasteners (3) to 7 N·m, plus 180° (62 in. lbs., plus 180°).
11. Connect the camshaft position sensor (4) and fuel injector wiring harness connectors.
12. Connect the return fuel hose (2) to each injector.
13. Install the fuel rail, high pressure fuel lines and injector cover.



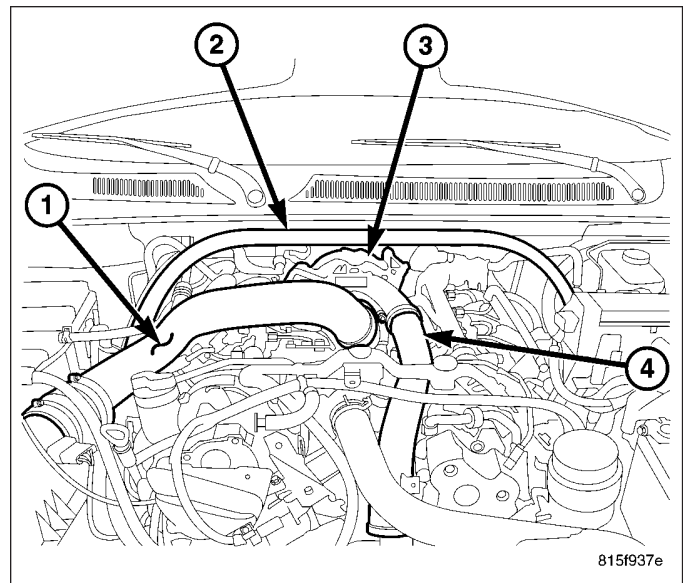
14. Secure the engine oil indicator tube (4) to the cylinder head. Tighten fastener to 11 N·m (8 in. lbs.).
15. Install the vacuum pump (1).
16. Install the air control valve resonator (2).



17. Install the air cleaner outlet tube to the turbo-charger and secure the air cleaner housing cover (2).



18. Install the strut tower support (2).

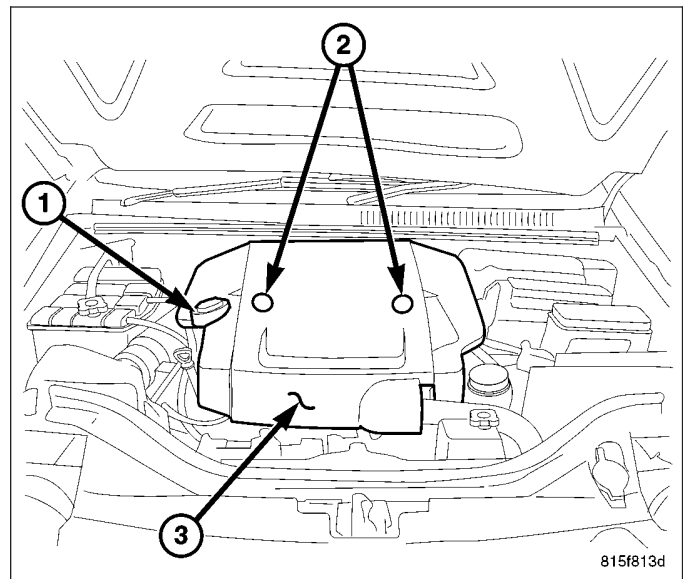


19. Connect the negative battery cable.

**NOTE: (Refer to 14 - FUEL SYSTEM - WARNING).**

20. Start engine, allow to warm, turn engine off and inspect for leaks.

21. Install the engine cover.



## CAMSHAFT(S)

### DESCRIPTION

The camshafts are multiple-piece components with six machined lobes that are mounted to a hollow shaft with an interference fit. The cam lobes are induction hardened. Each camshaft has four bearing journals except for the right-bank intake camshaft. Due to the longer length needed to accommodate the centrifugal oil separator, the right-bank intake camshaft has five bearing journals. The camshaft journals have the same diameter and are supplied with oil pressure through lubrication passages in the cylinder head journals. The cylinder head covers provide the upper bearing support for the camshafts. Each camshaft contains two retaining brackets, which prevent the camshafts from coming out of their journals when the cylinder head covers are removed. The retaining brackets are not designed to hold the camshafts if the engine is rotated without the cylinder head covers. Special tool #9555 must be installed if the engine is rotated without the cylinder head covers.

### OPERATION

Each cylinder has two intake and two exhaust valves, and one glow plug. Valve lash is controlled by hydraulic lifter/roller finger followers inside the cylinder head, in bores under the camshafts. The finger followers transfer the camshaft lobe movement into vertical valve movement. The valve moves by the lobe of the camshaft pressing down on the finger follower roller.

The finger followers are located on top of the hydraulic lifters and the valves. The finger followers are not held rigidly into position; instead, they are held in position by resting on top of the valve and the hydraulic lifter pivoting ball. A holding clip secures the finger follower to the hydraulic lifter.

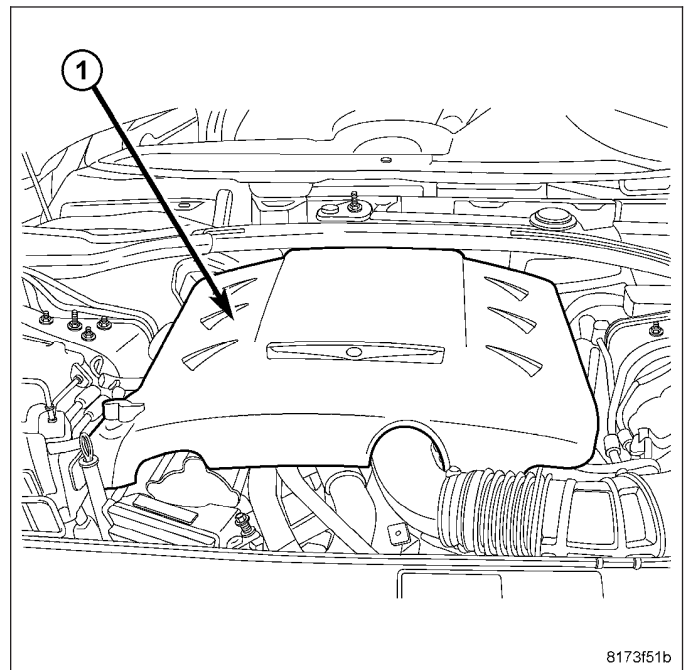
**WARNING:** When the hydraulic lash adjusters are removed from the engine, they must be stored upright and in clean conditions. Install the finger followers and hydraulic lifters in the same location as removed.

**WARNING:** Replacement of the camshaft will also require replacement of the finger followers and hydraulic lifters.

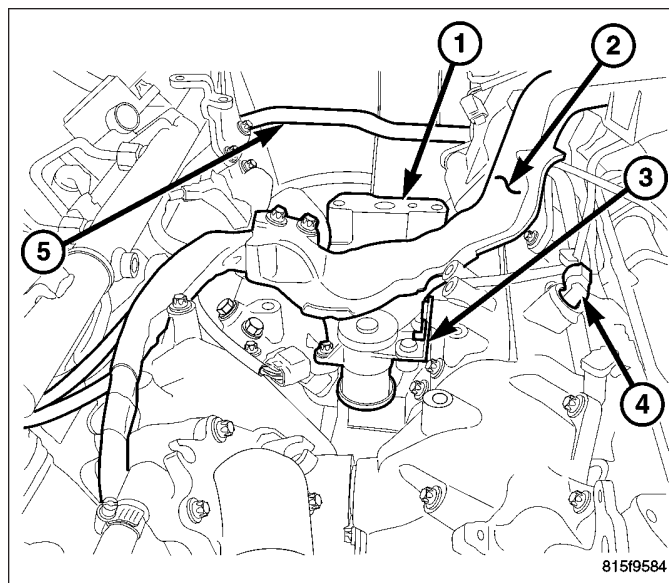
### REMOVAL

#### LEFT

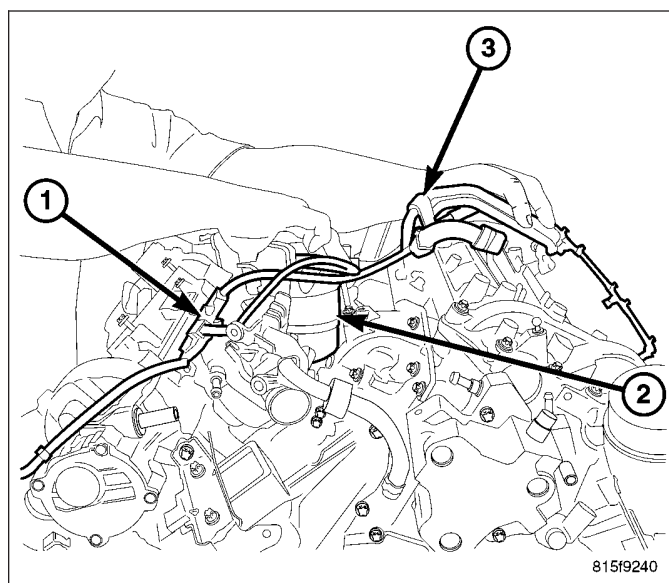
1. Disconnect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Remove engine cover.



3. Rotate the engine to TDC using the vibration damper bolt.
4. Remove the main engine wiring harness retainers at the rear of the cylinder head cover.
5. Remove the EGR valve.
6. Remove the charge air inlet tube.
7. Disconnect the fuel line hoses at the fuel rail, high pressure pump using 9539 Pliers.
8. Disconnect the fuel lines at the left cylinder head.

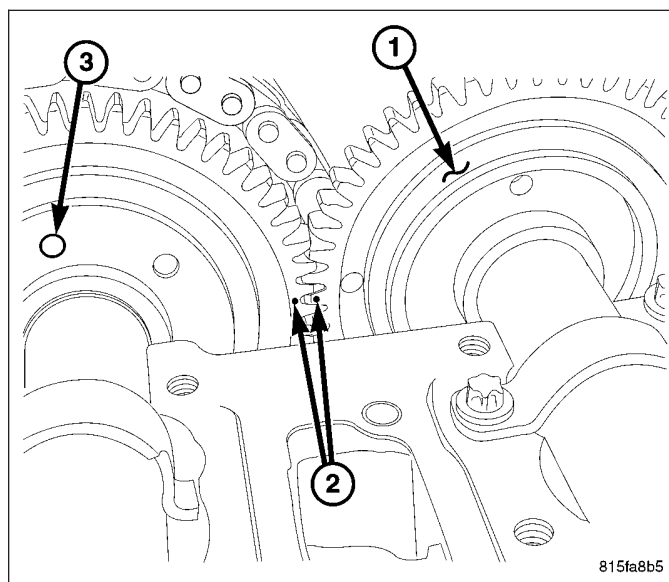


9. Remove the fuel pipe bundle and set aside.
10. Remove the oil filter housing support bracket.
11. Remove the cylinder head cover.

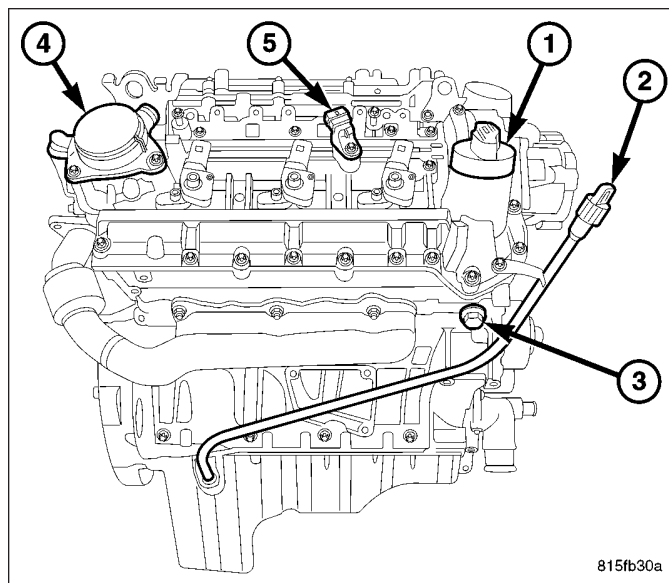


**NOTE:** The left exhaust camshaft gear alignment mark is located in the gear tooth valley. The left intake camshaft gear mark is located on the outside of the tooth.

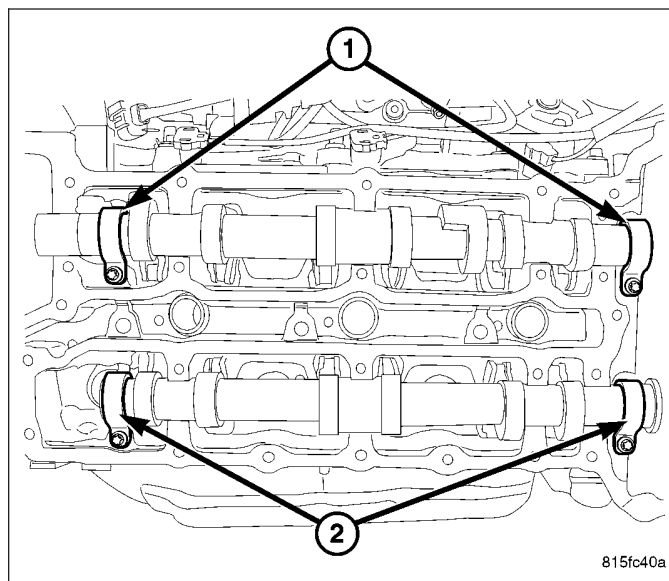
12. Check the camshaft timing gears for alignment. The alignment marks should be touching and the exhaust camshaft drive gear alignment pin should be located at approximately 12 o'clock, when viewed from the front camshaft seal.
13. Rotate the engine by the vibration damper bolt, past TDC to gain access to the lower camshaft drive gear bolt, and remove the bolt.
14. Rotate the engine back to TDC and check camshaft gear alignment.



15. Remove the timing chain tensioner (3).
16. Paint mark or scribe the timing chain to drive gear relation.
17. Tie strap the timing chain to drive gear.
18. Remove the remaining camshaft drive gear bolts and separate the drive gear from camshaft gear.

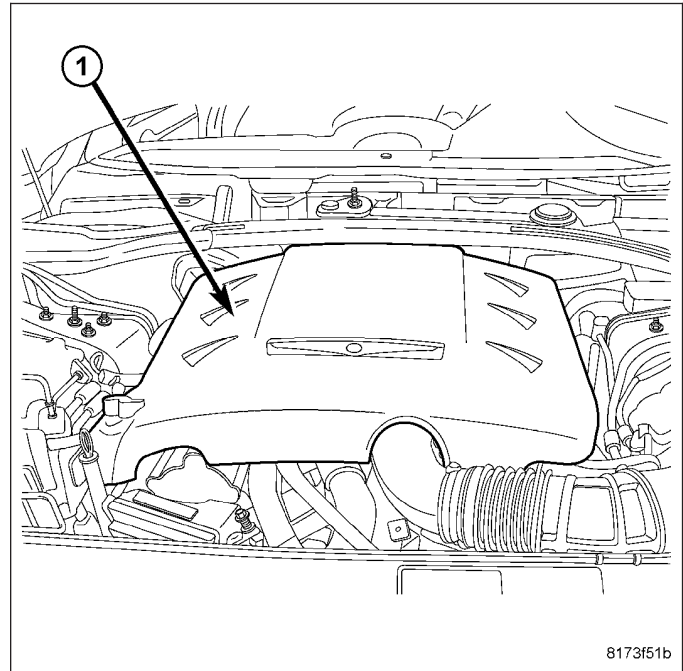


19. Remove the intake and exhaust camshaft retainers.
20. Remove the left cylinder head camshafts.

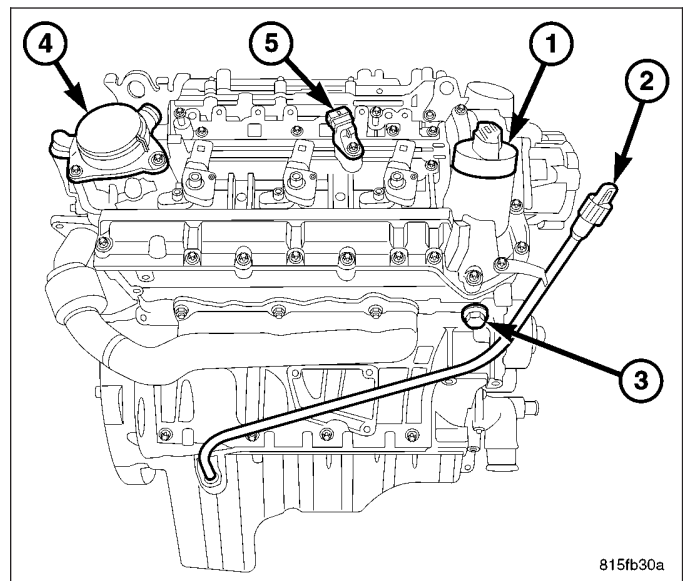


**RIGHT**

1. Disconnect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Remove engine cover.
3. Rotate the engine to TDC using the vibration damper bolt.



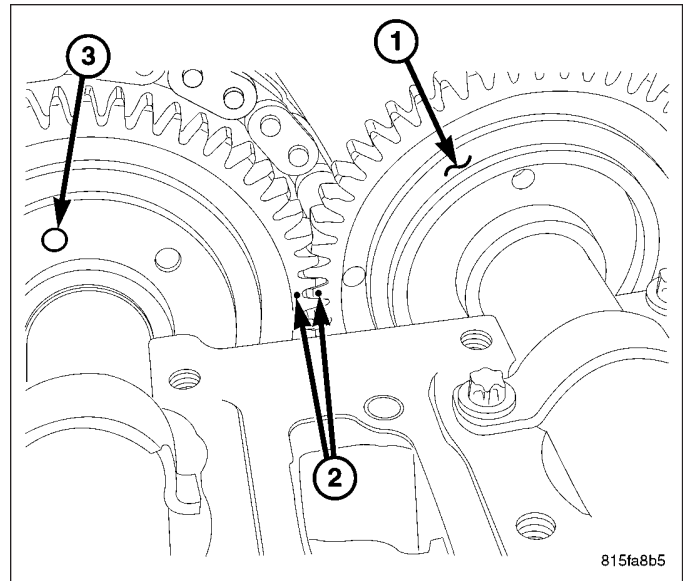
4. Remove the intake air resonator.
5. Remove the vacuum pump.
6. Remove the oil level indicator tube (2) retaining bolt at the right cylinder head cover.
7. Remove the crankcase breather assembly (4) from the right cylinder head cover.
8. Remove the cylinder head cover. (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL)



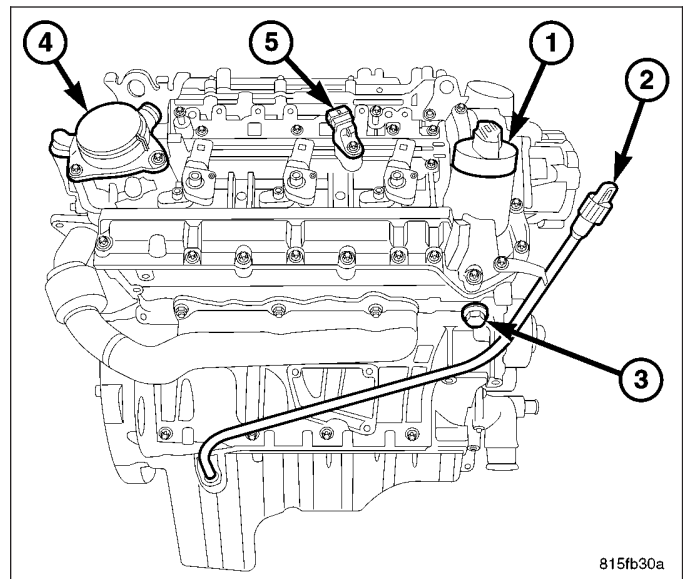


**NOTE:** The right exhaust camshaft gear alignment mark is located in the gear tooth valley. The left intake camshaft gear mark is located on the outside of the tooth.

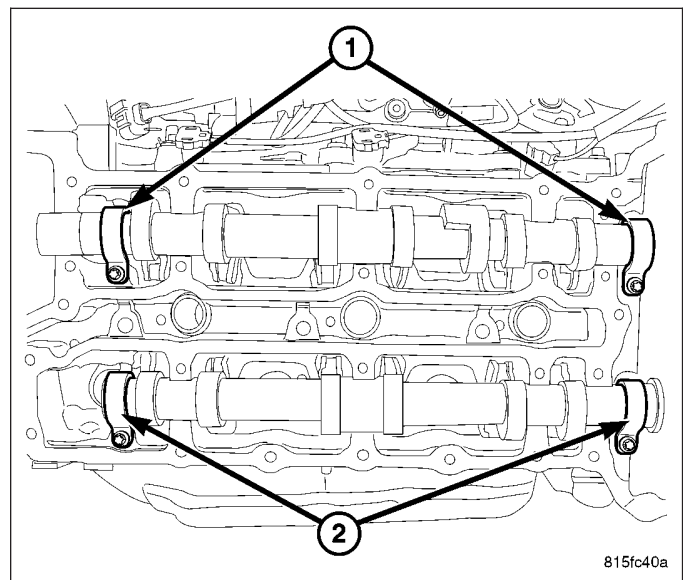
9. Check the camshaft timing gears for alignment. The alignment marks should be touching and the exhaust camshaft drive gear alignment pin should be located at approximately 12 o'clock, when viewed from the front camshaft seal.
10. Rotate the engine by the vibration damper bolt, past TDC to gain access to the lower camshaft drive gear bolt, and remove the bolt.
11. Rotate the engine back to TDC and check camshaft gear alignment.



12. Remove the timing chain tensioner (3).



13. Paint mark or scribe the timing chain to drive gear relation.
14. Tie strap the timing chain to drive gear.
15. Remove the remaining camshaft drive gear bolts and separate the drive gear from camshaft gear.
16. Remove the intake and exhaust camshaft retainers.
17. Remove the left cylinder head camshafts.



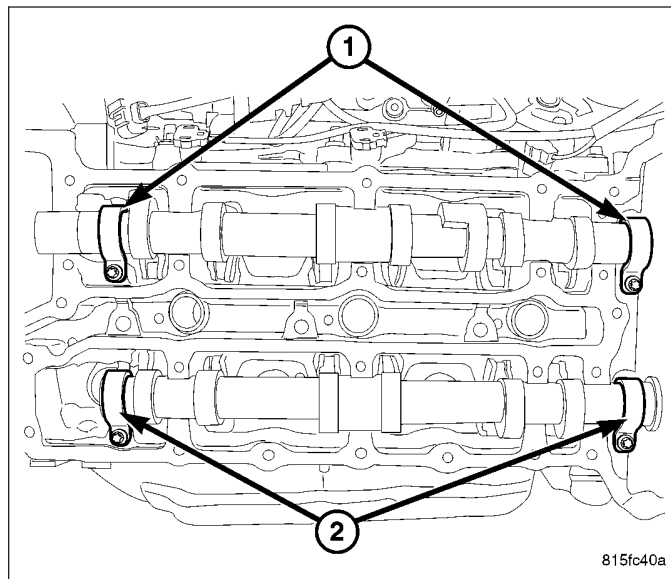
## INSTALLATION

### LEFT

1. Clean all mating surfaces.
2. Lubricate camshafts with Mopar® Engine Oil Supplement, or equivalent.
3. Carefully install camshafts onto cylinder head journals and align the camshaft gear timing marks.
4. Install the camshaft retainers and tighten each retaining bolt to 9 N·m (80 in. lbs.).

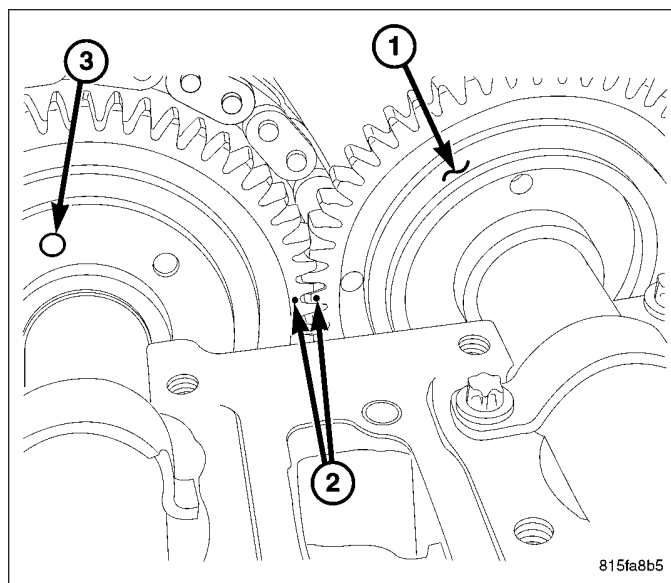
**NOTE:** If the camshaft endplay is not within specification, replace the cylinder head cover.

5. After camshafts are properly installed in cylinder head cover check end play of camshafts with a dial indicator.

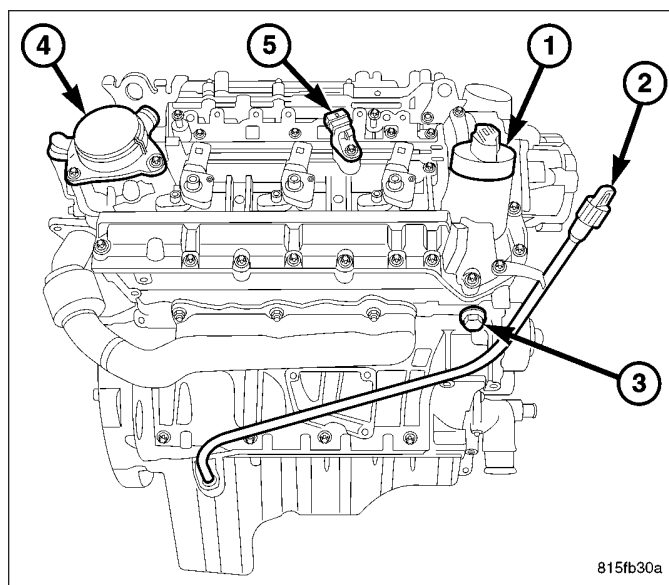


**NOTE:** The left exhaust camshaft gear alignment mark is located in the gear tooth valley. The left intake camshaft gear mark is located on the outside of the tooth. The alignment marks should be touching and the exhaust camshaft drive gear alignment pin should be located at approximately 12 o'clock, when viewed from the front camshaft seal.

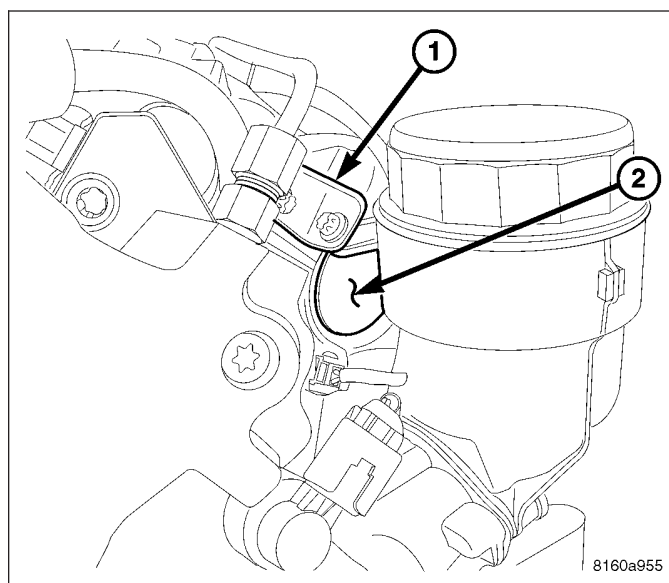
6. Assure the proper positioning of the camshaft gear alignment marks and install the camshaft driven gear onto the exhaust camshaft alignment dowel.
7. Install two of the drive gear bolts. Tighten the bolts to 18 N·m (13 ft. lbs.).
8. Assure proper positioning of the timing chain to drive gear paint or scribe marks and remove the tie strap.
9. Rotate the engine by the vibration damper bolt enough to install the third camshaft drive gear bolt. Tighten the bolt to 18 N·m (13 ft. lbs.).
10. Rotate the engine back to TDC and check camshaft gear alignment.



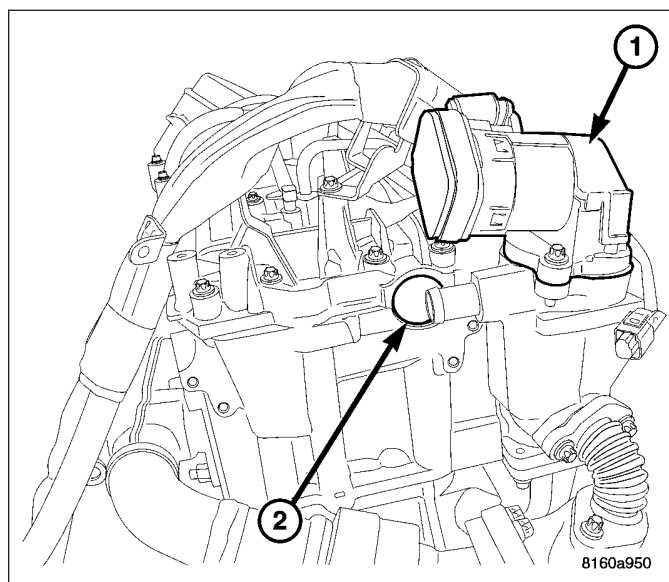
11. Install the timing chain tensioner.



12. Install the left front camshaft oil seal (2).



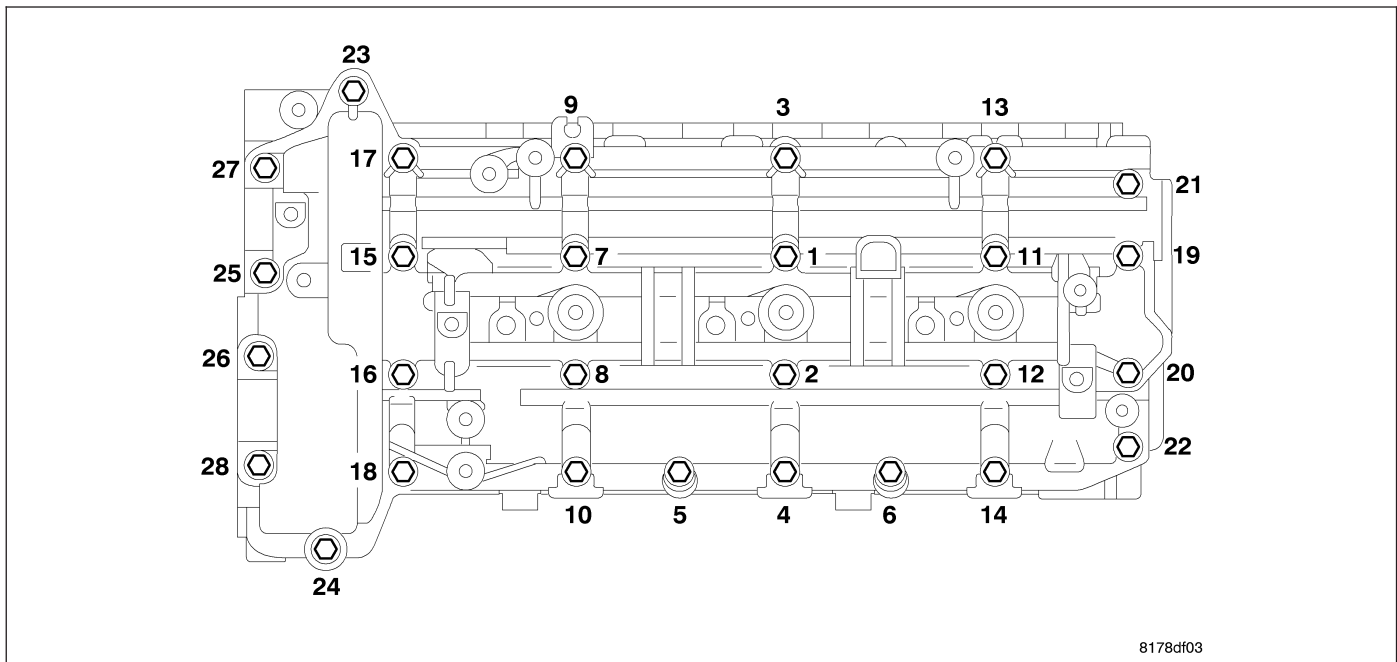
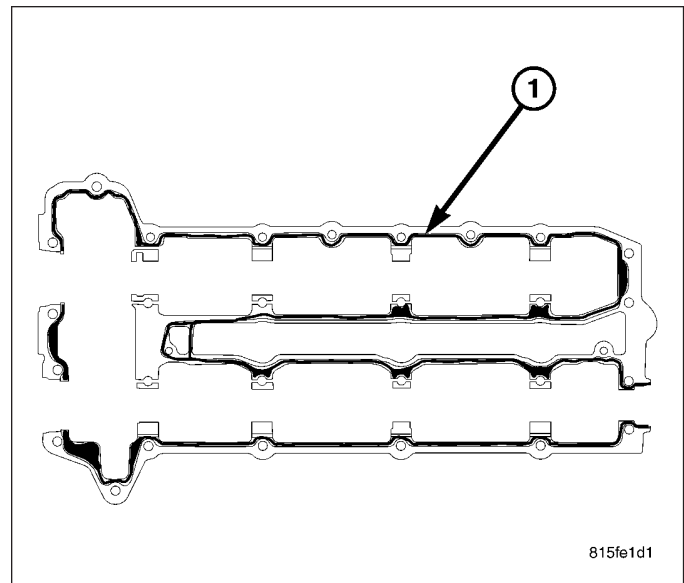
13. Install the left rear camshaft oil seal (2).



14. Clean and inspect all sealing surfaces.

**NOTE:** Care must be taken not to get any engine sealant on the camshaft journals of the cylinder head cover.

15. Install a 1/8 in bead of Mopar Engine RTV Gen II sealant to the underside of the cylinder head cover (Refer to 9 - ENGINE - STANDARD PROCEDURE).



16. Carefully position the cylinder head cover and install the bolts into their original position.

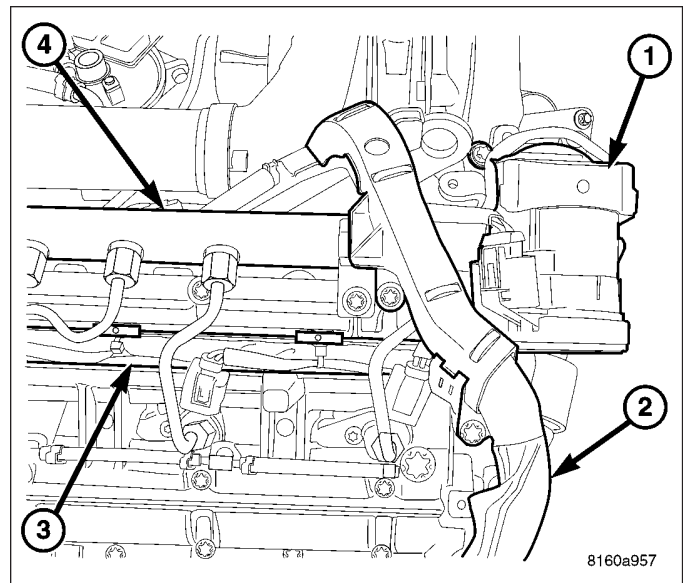
**CAUTION:** The cylinder head cover bolts are different lengths. Do not use the wrong length bolts or engine damage may result.

17. Tighten cylinder head cover bolts in sequence, first to 4 N·m (35 in. lbs.), and then repeat the sequence to 8.4 N·m (75 in. lbs.).

18. Install the EGR valve.

**CAUTION:** The fuel injector sealing washers **MUST** be replaced. **DO NOT** use the old sealing washers or double the sealing washers.

**NOTE:** Care must be taken not to apply any lubricant to the fuel injector nozzles.



19. Install the fuel injectors (1). Tighten the injector retaining claw bolt to 7 N·m (5 ft. lbs.) and then an additional 180°.

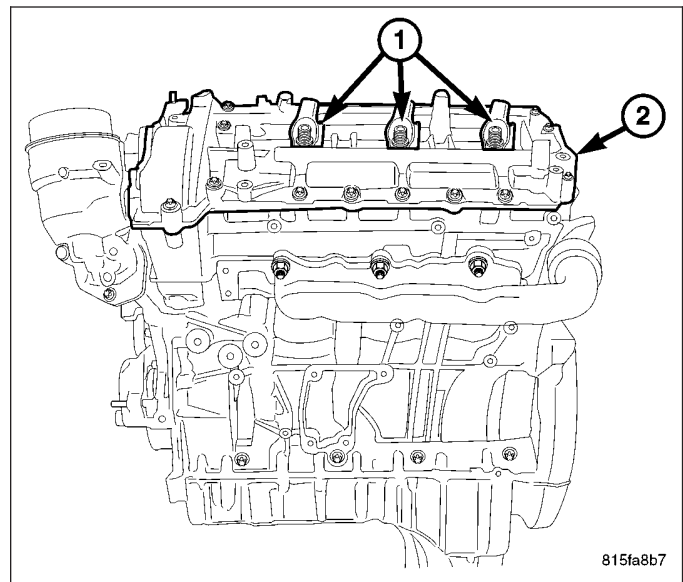
20. Re-position and secure the engine harness.

21. Install the left fuel rail. Tighten the fuel rail bolts to 11 N·m (8 in. lbs.).

22. Position the return fuel lines and secure to the injectors. Push down on the release lock tab to secure.

23. Connect the fuel injector electrical connectors.

24. Install the left rear engine cover bracket.

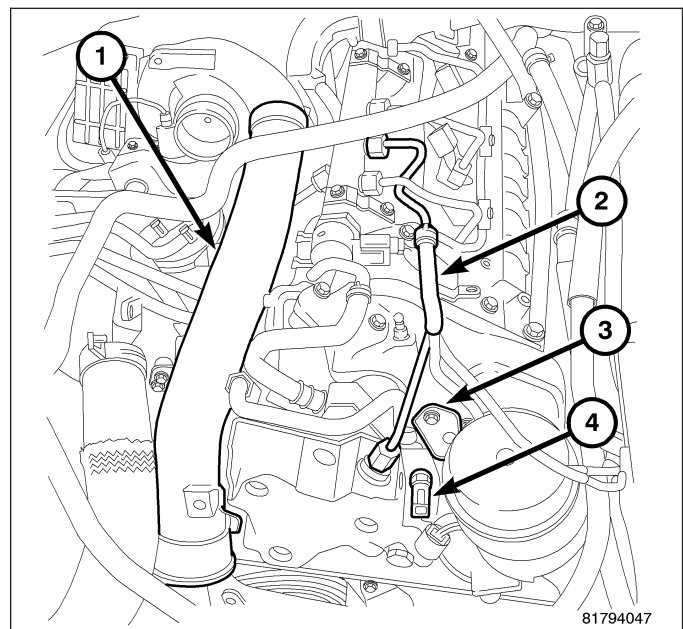


25. Install the high pressure fuel lines from the fuel rail to injectors. Tighten the line connections to 27 N·m (20 ft. lbs.).

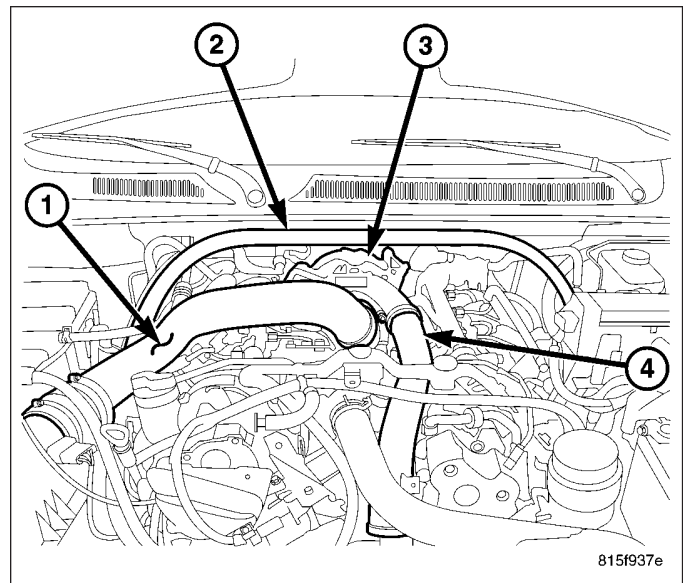
26. Install the fuel line from the high pressure pump to the left fuel rail. Tighten the retaining bolt to 30 N·m (22 ft. lbs.).

27. Install the fuel supply line to the fuel filter and high pressure pump.

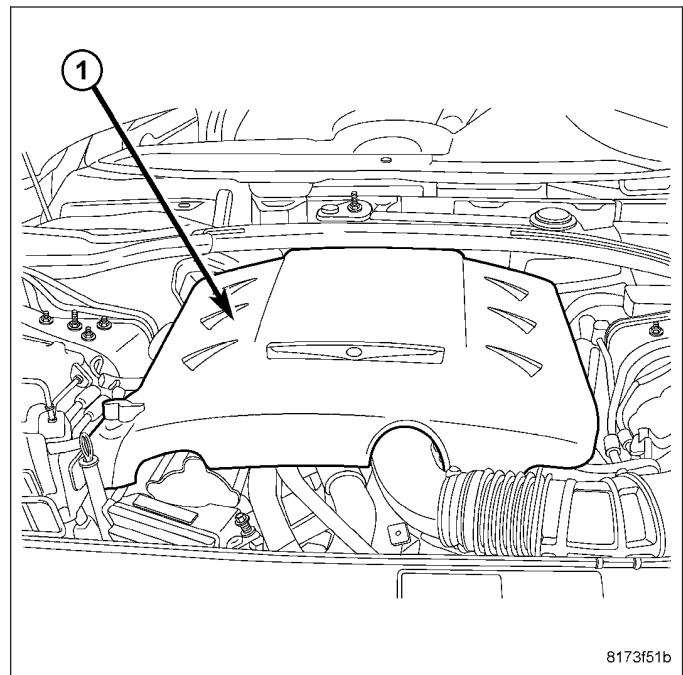
28. Connect both fuel lines at the high pressure pump.



- 29. Install the air filter housing and tube.
- 30. Connect the negative battery cable.
- 31. Start the engine, run until warm, turn engine off and inspect for leaks (Refer to 14 - FUEL SYSTEM - WARNING).

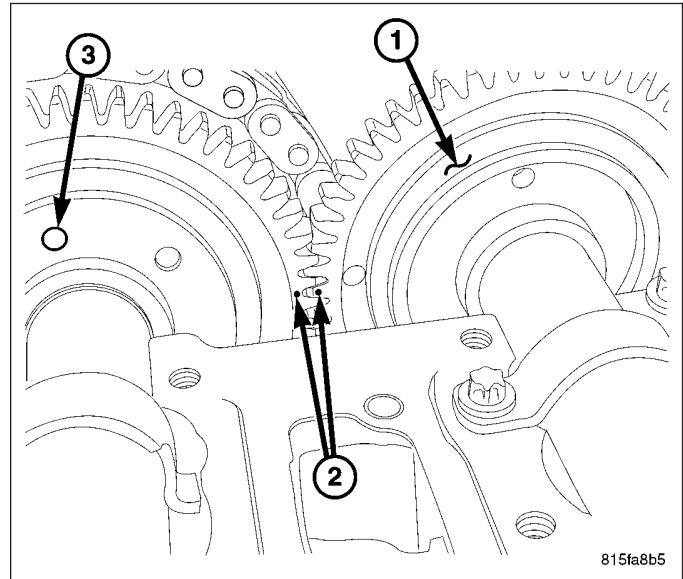


- 32. Install the engine cover.
- 33. Connect negative battery cable.
- 34. Start engine, allow to warm, turn engine off and inspect for leaks (Refer to 14 - FUEL SYSTEM - WARNING).



**RIGHT**

1. Clean all mating surfaces.
2. Lubricate camshafts with Mopar® Engine Oil Supplement, or equivalent.
3. Carefully install camshafts onto cylinder head journals and align the camshaft gear timing marks.

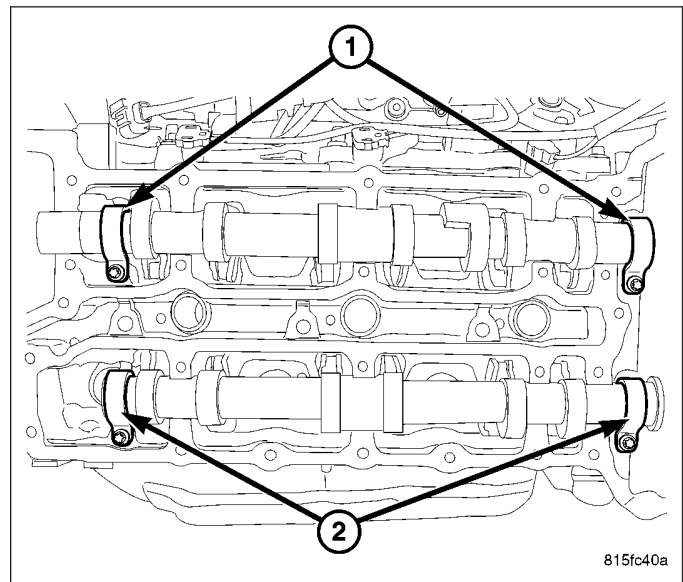


4. Install the camshaft retainers and tighten each retaining bolt to 9 N·m (80 in. lbs.).

**NOTE:** If the camshaft endplay is not within specification, replace the cylinder head cover.

5. After camshafts are properly installed in cylinder head cover check end play of camshafts with a dial indicator.

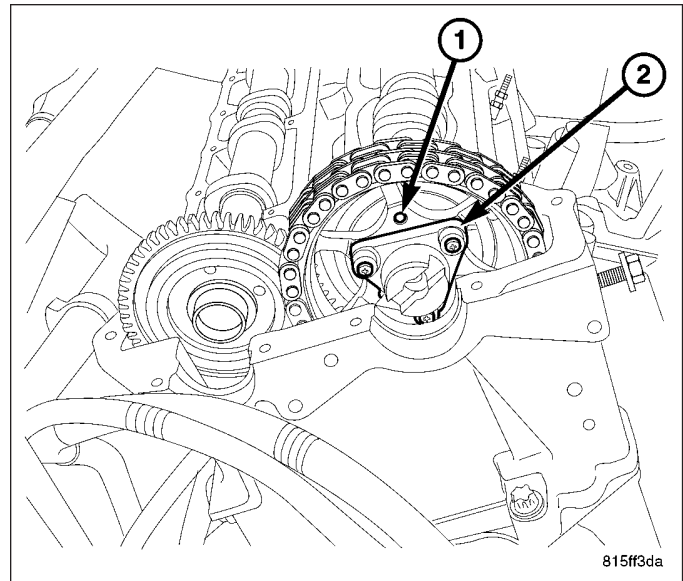
**NOTE:** The right exhaust camshaft gear alignment mark is located in the gear tooth valley. The right intake camshaft gear mark is located on the outside of the tooth. The alignment marks should be touching and the exhaust camshaft drive gear alignment pin should be located at approximately 12 o'clock, when viewed from the front camshaft seal.



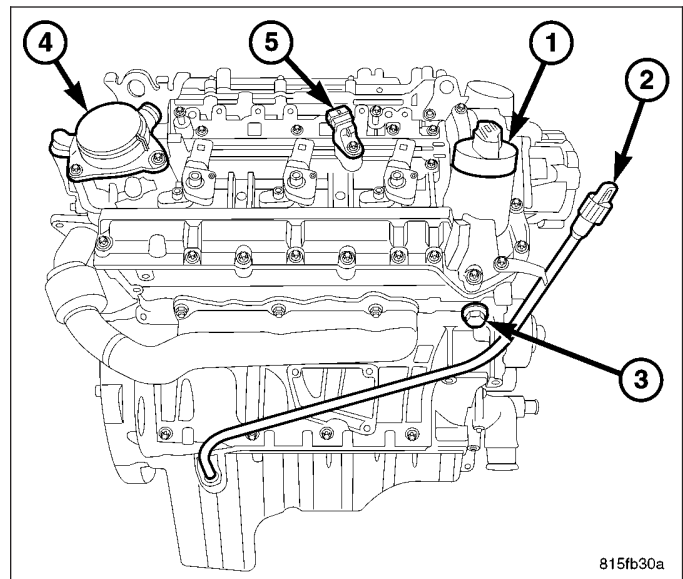
6. Assure the proper positioning of the camshaft gear alignment marks and install the camshaft driven gear onto the exhaust camshaft alignment dowel.



7. Install two of the drive gear bolts. Tighten the bolts to 18 N·m (13 ft. lbs.).
8. Assure proper positioning of the timing chain to drive gear paint or scribe marks and remove the tie strap.
9. Rotate the engine by the vibration damper bolt enough to install the third camshaft drive gear bolt. Tighten the bolt to 18 N·m (13 ft. lbs.).
10. Rotate the engine back to TDC and check camshaft gear alignment.

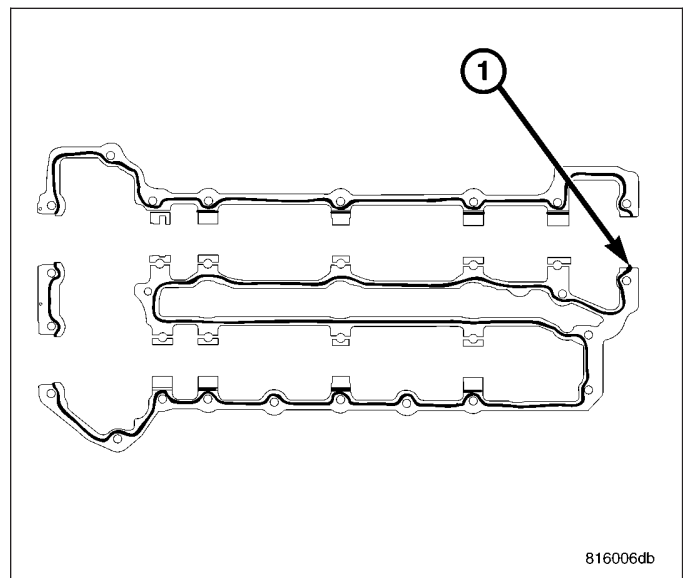


11. Install the timing chain tensioner (3).

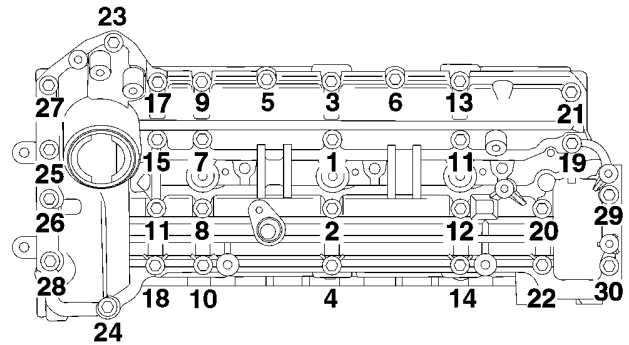


**NOTE:** Care must be taken not to get any engine sealer on the camshaft journals.

12. Clean all mating surfaces.
13. Apply a 1.5MM bead of Mopar<sup>®</sup> Engine RTV Sealant (1) to the cylinder head cover.

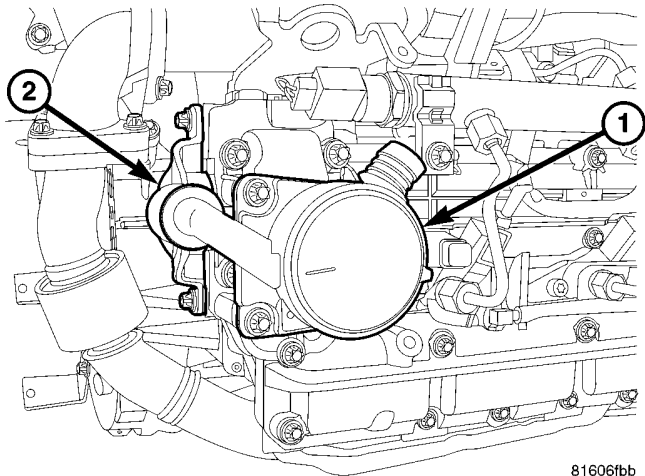


14. Place the camshaft seal into position.
15. Install the cylinder head cover. Tighten the bolts in three stages following the sequence provided. First to 4 N·M (35 in. lbs.), then to 6 N·m (53 in. lbs.), and then to 8.4 N·m (75 in. lbs.).



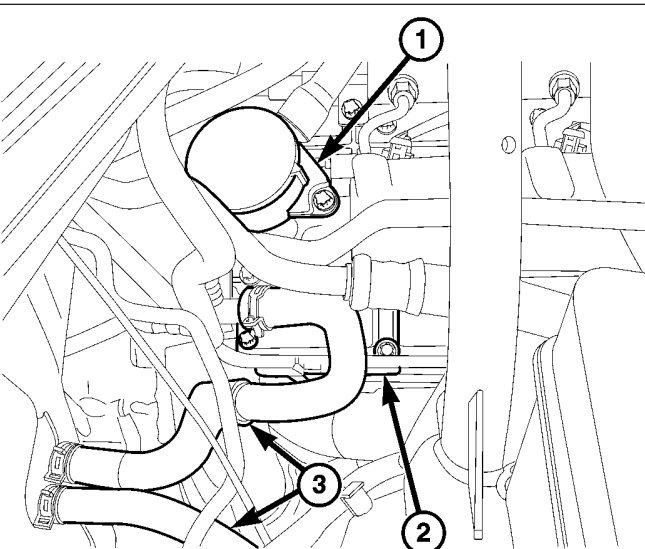
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16. Install the oil separator housing adaptor (2) with new camshaft seal. Tighten fasteners to 9 N·m (7 ft. lbs.).
17. Install the oil separator (1). Tighten fasteners to 9 N·m (7 ft. lbs.).



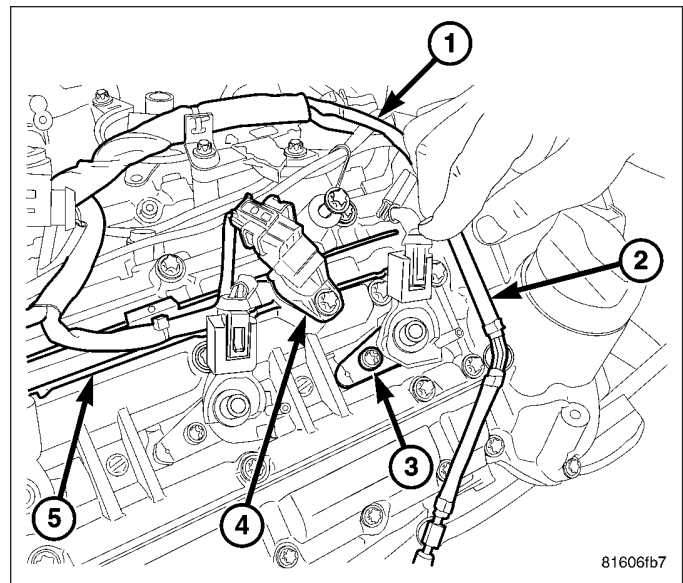
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18. Secure the transmission tube fastener to the engine cover bracket.
19. Secure the heater hose bracket (2) to the cylinder head cover.

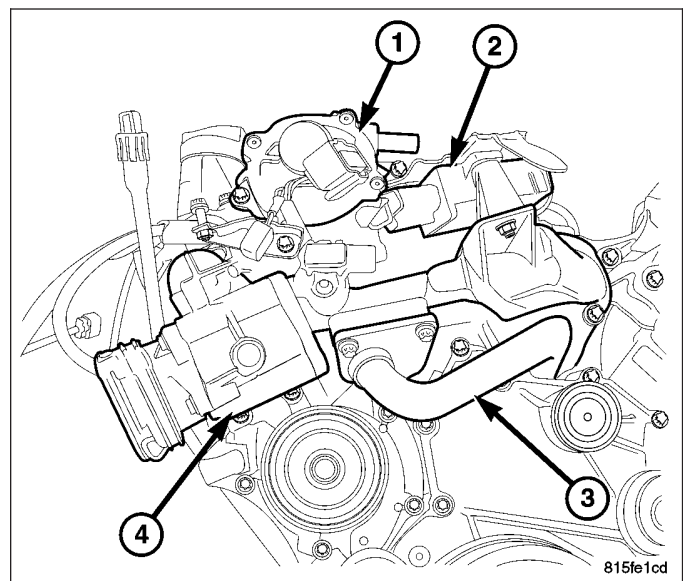


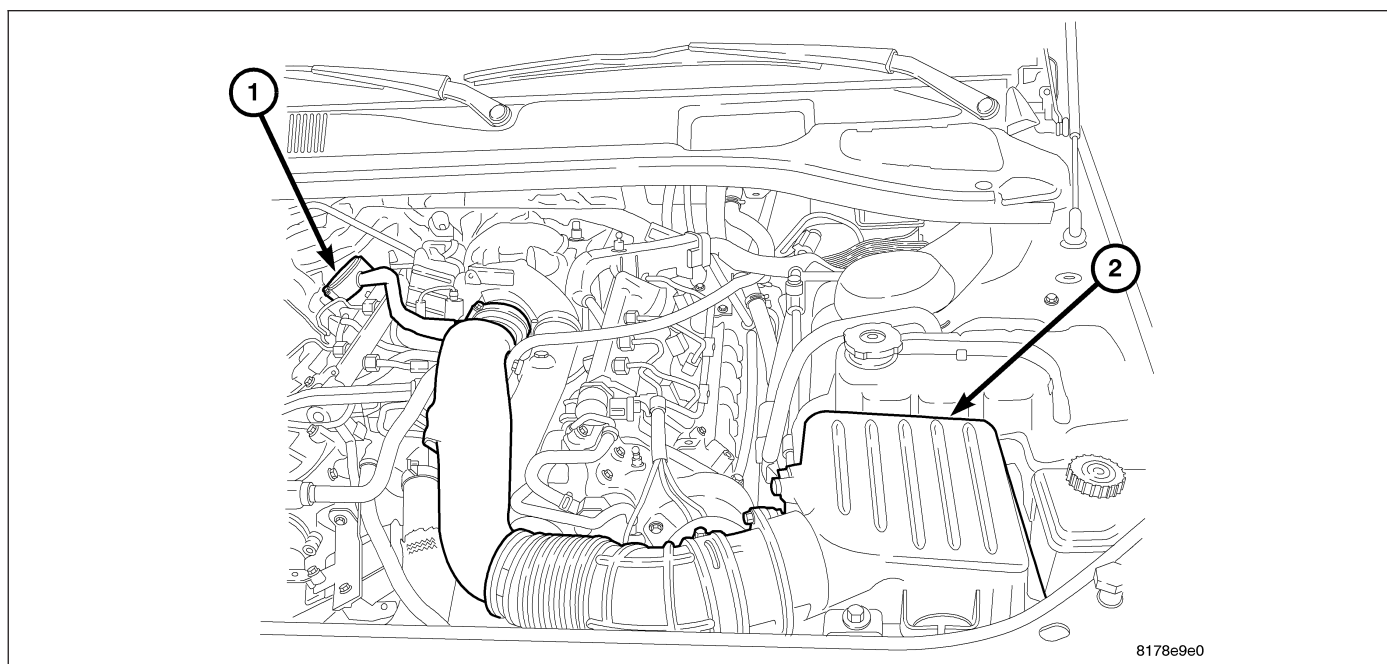
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20. Secure the vacuum pump hose pipe to the cylinder head cover.
21. Install the fuel injectors. Tighten hold down fasteners (3) to 7 N·m, plus 180° (62 in. lbs., plus 180°).
22. Connect the camshaft position sensor (4) and fuel injector wiring harness connectors.
23. Connect the return fuel hose (2) to each injector.
24. Install the fuel rail, high pressure fuel lines and injector cover.

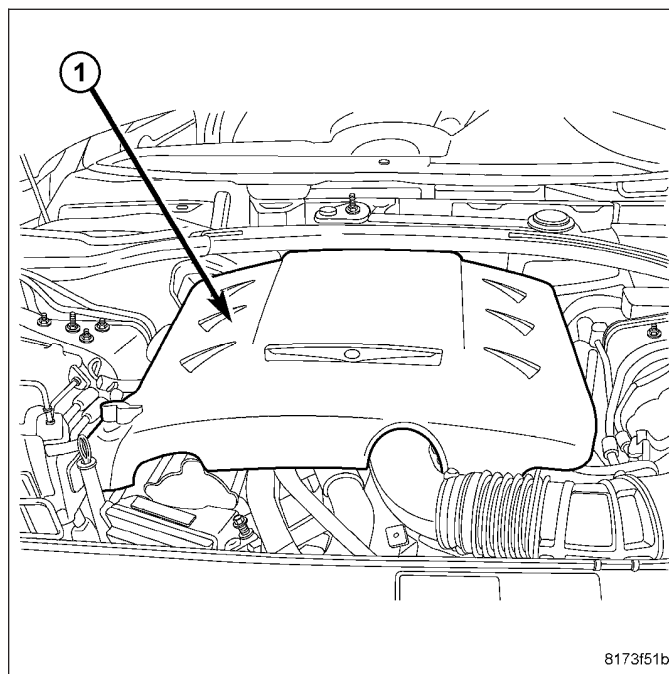


25. Secure the engine oil indicator tube (4) to the cylinder head. Tighten fastener to 11 N·m (8 in. lbs.).
26. Install the vacuum pump (1).
27. Install the air control valve resonator (2).





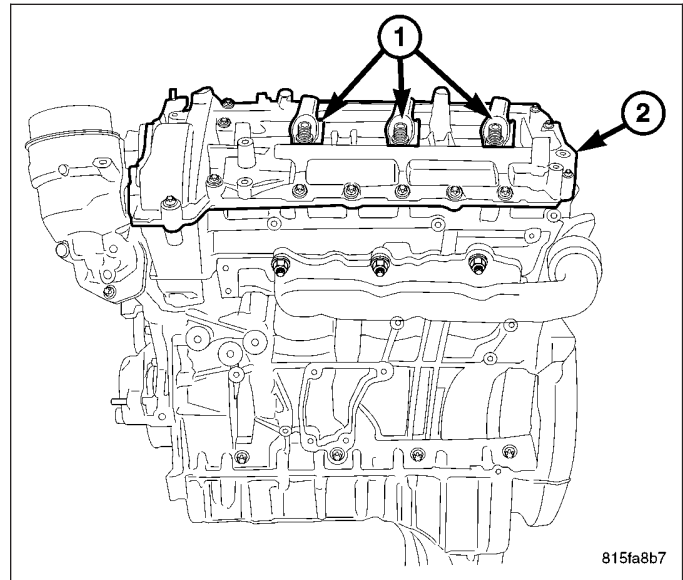
28. Install the air cleaner outlet tube to the turbocharger and secure the air cleaner housing cover (2)
29. Install the engine cover.
30. Connect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
31. Start engine, allow to warm, turn engine off and inspect for leaks (Refer to 14 - FUEL SYSTEM - WARNING).



## CYLINDER HEAD COVER

### DESCRIPTION

The 3.0L cylinder head covers are made of cast aluminum and incorporate a oil drain back hole for the crankcase ventilation (CCV) system. The covers serve as engine noise inhibitors and are specifically designed to act as camshaft main caps and thrust washers. Care must be taken when sealing the cover as too much sealant, or sealant installed improperly may effect camshaft main cap clearances.



### REMOVAL

#### RIGHT

1. Disconnect the negative battery cable.
2. Position the coolant reservoir aside.
3. Remove the strut tower support.
4. Remove engine cover.
5. Remove engine cover front bracket.
6. Remove air cleaner cover and inlet tube to turbocharger.
7. Remove engine cover right rear bracket.
8. Remove the crankcase ventilation valve (CCV) and breather tube.
9. Disconnect the fuel return line.
10. Disconnect the fuel supply and return lines at the right cylinder head cover.
11. Disconnect the camshaft position sensor (CMP) and fuel injector wiring and position the right engine wiring harness aside.
12. Pull out on the fuel injector return fuel hose retainers, disconnect the hoses and position aside.
13. Remove the right fuel injectors.
14. Remove the air conditioning (A/C) / heater hose bracket.
15. Remove the oil level indicator tube retaining bolt.
16. Remove the EGR air control valve assembly resonator.
17. Remove the vacuum pump.
18. Remove the cylinder head cover retaining bolts and remove cover.

## INSTALLATION

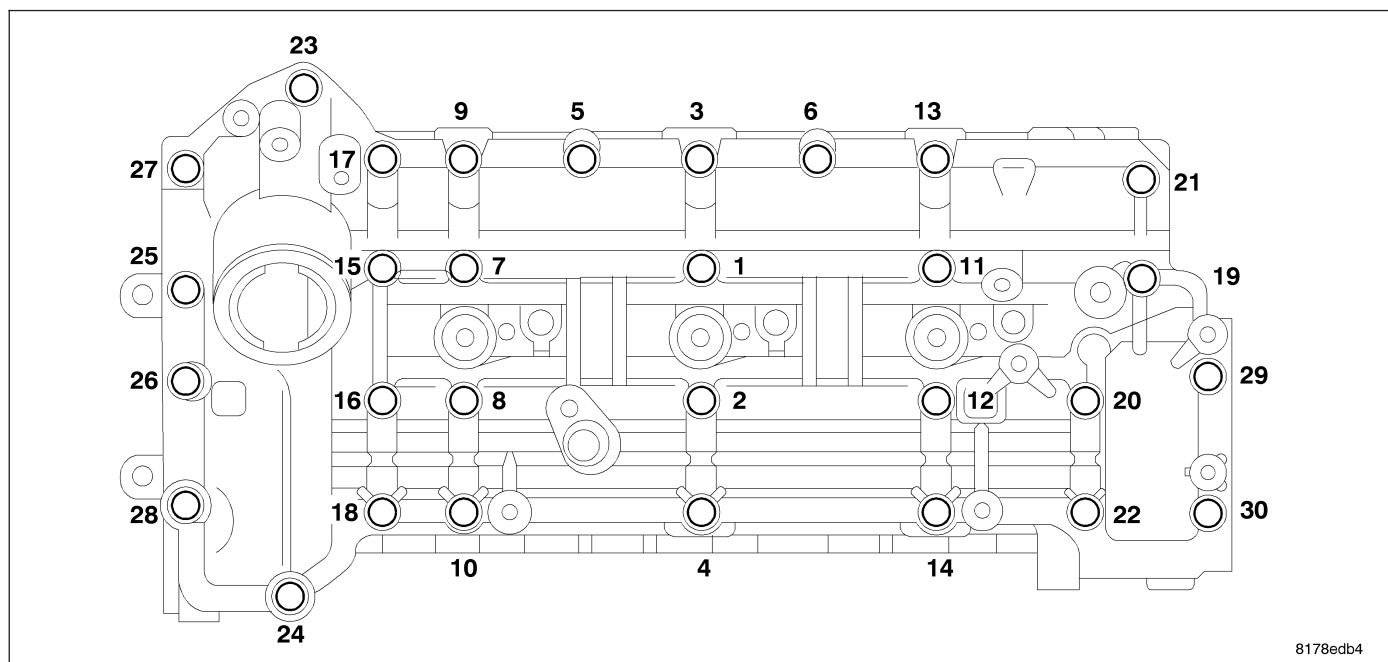
### RIGHT

1. Clean and inspect all sealing surfaces.

**NOTE:** Care must be taken not to get any engine sealant on the camshaft journals of the cylinder head cover.

2. Install a 1/8 in bead of Mopar Engine RTV Gen II sealant to the underside of the cylinder head cover (Refer to 9 - ENGINE - STANDARD PROCEDURE).

**CAUTION:** The cylinder head cover bolts are different lengths. Make sure to install the bolts into their original position.



3. Carefully position the cylinder head cover and install the bolts into their original position.
4. Tighten cylinder head cover bolts in sequence, first to 4 N·m (35 in. lbs.), and then repeat the sequence to 8.4 N·m (75 in. lbs.).

**CAUTION:** Make sure to replace the lower copper washer seal on the injector. DO NOT re-use the old seal, DO NOT double the seals.

5. Install the fuel injectors. Tighten the retaining claw bolts to 7 N·m (5 ft. lbs.) and then an additional 180°.
6. Install the CCV housing. Tighten the fasteners to 9 N·m (80 in. lbs.).
7. Install the vacuum pump. Tighten the fasteners to 9 N·m (80 in. lbs.).
8. Install the EGR air control valve resonator. Tighten the fasteners to 9 N·m (80 in. lbs.).
9. Install the oil level indicator tube fastener. Tighten the bolt to 11 N·m (97 in. lbs.).
10. Install the AC / heater hose bracket. Tighten the bolts to 9 N·m (80 in. lbs.).
11. Install the fuel rail. Tighten bolts to 9 N·m (80 ft. lbs.).

**NOTE:** Inspect all fuel lines for damage or wear. Replace as necessary. DO NOT over tighten the fuel line nuts.

12. Install the fuel injector high pressure lines. Tighten line nuts to 33 N·m (24 ft. lbs.).
13. Position the engine wiring harness and connect the CMP, fuel rail pressure sensor and fuel injectors.
14. Connect the fuel return hoses to fuel injectors, pushing down on the hose retainers.

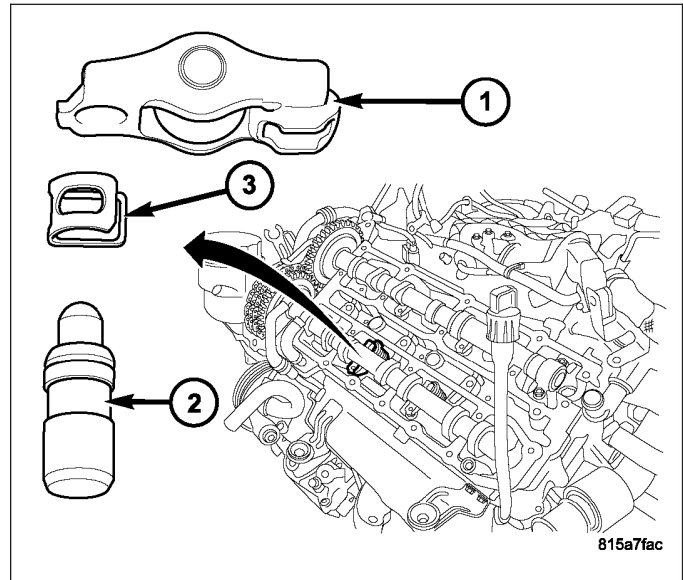
15. Install the air cleaner cover and inlet tube.
16. Install the rear engine cover bracket.
17. Connect the CCV hose to air inlet tube and connect the CCV heater wiring harness connector.
18. Install the engine cover.
19. Install the strut tower support.
20. Install the coolant reservoir.
21. Connect the negative battery cable.
22. Start engine, allow to warm, turn engine off and inspect for leaks (Refer to 14 - FUEL SYSTEM - WARNING).



## ARMS-ROCKER

### DESCRIPTION

The rocker arms (1) are located on the top of the hydraulic lifters (2) and the valves. The rocker arms are not held rigidly into position; instead they are held in position by resting on top of the valve and the hydraulic lifter pivoting ball. A holding clip (3) secures the rocker arm to the hydraulic lifter.



### OPERATION

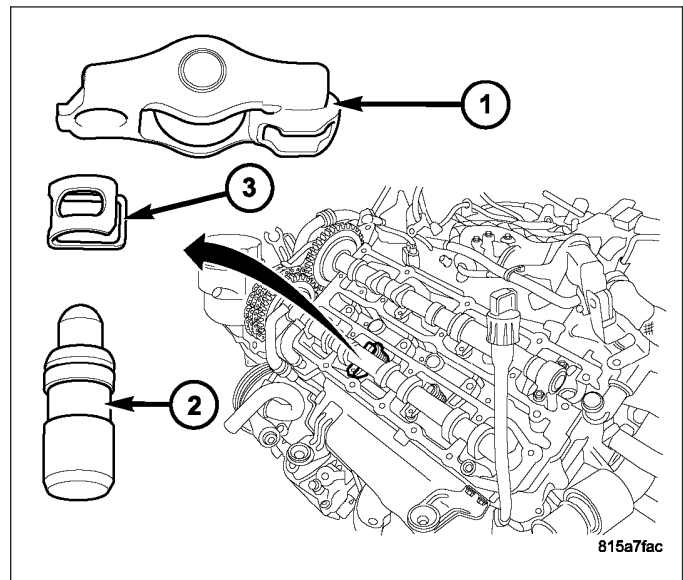
The rocker arms are used as a link between the camshaft and valves. As the camshaft rotates, the lobes of the camshafts apply downward pressure on the rocker arms. This pressure is then transmitted to the valves which causes the valves to open.

### REMOVAL

1. Remove the appropriate camshafts. (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - LEFT - REMOVAL) or (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - RIGHT - REMOVAL).
2. Remove the rocker arm (1) and lifter (2) assembly.

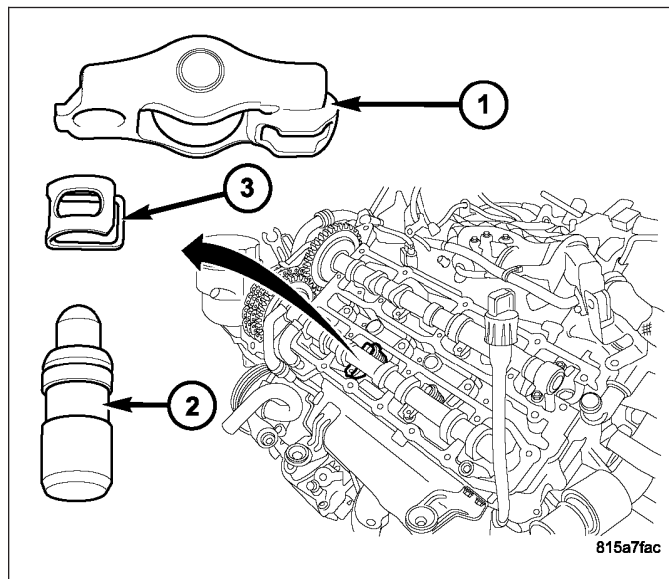
**NOTE:** When the hydraulic lifters are removed from the engine, they must be stored upright and in clean conditions.

3. Separate the rocker arm from the lifter.



## INSTALLATION

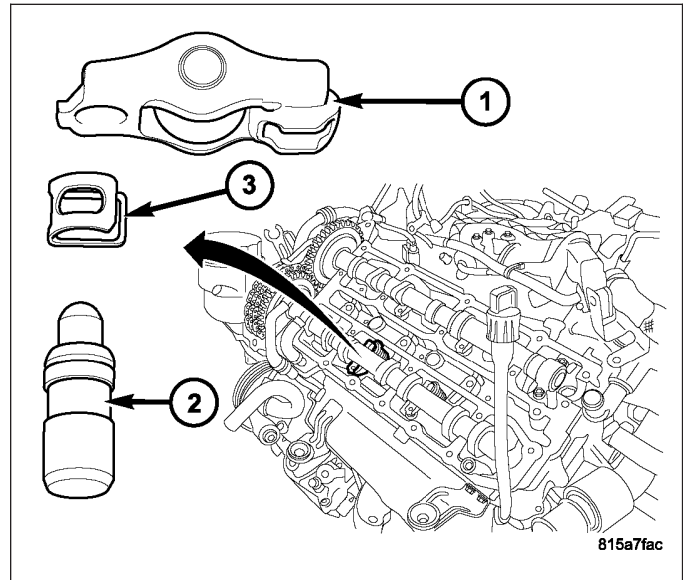
1. Assemble the rocker arm (1) to the hydraulic lifter (2) with the retaining clip (3).
2. Install the rocker arm and lifter assembly onto the cylinder head.
3. Install the camshaft(s). (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - LEFT - INSTALLATION) or (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - RIGHT - INSTALLATION).



## LIFTERS-HYDRAULIC

### DESCRIPTION

Valve lash is controlled by hydraulic lifters (2) located inside the cylinder head, in tappet bores below the camshafts.

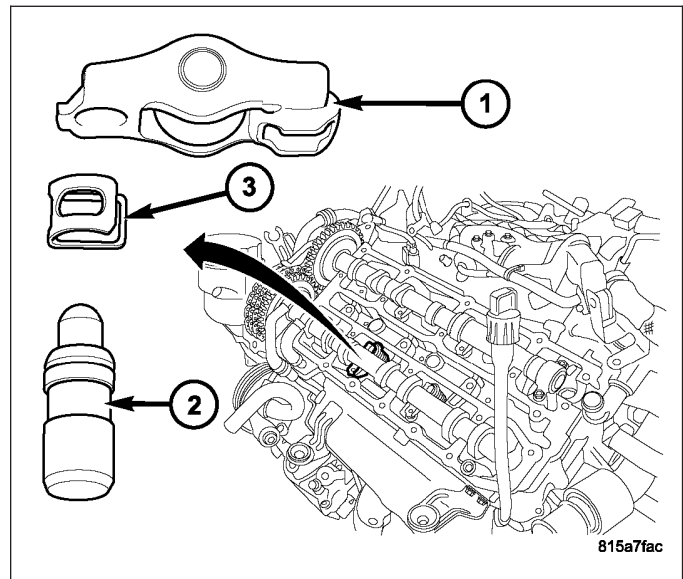


### REMOVAL

1. Remove the appropriate camshafts. (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - LEFT - REMOVAL) or (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - RIGHT - REMOVAL).
2. Remove the rocker arm (1) and lifter (2) assembly.

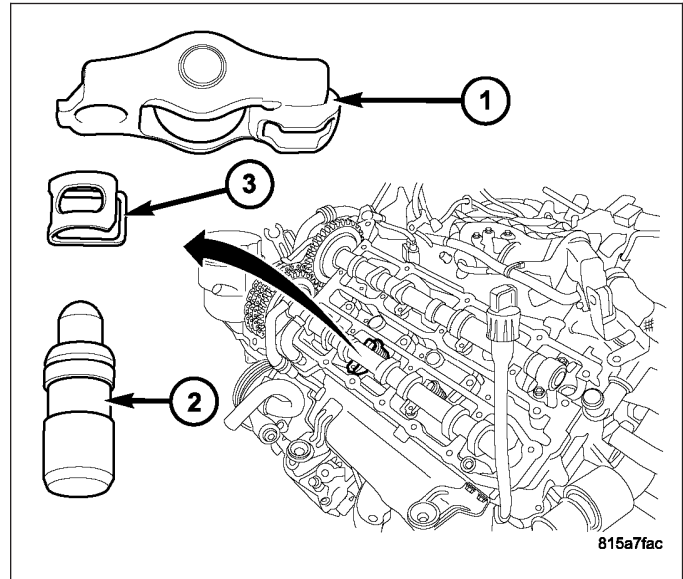
**NOTE:** When the hydraulic lifters are removed from the engine, they must be stored upright and in clean conditions.

3. Separate the lifter from the rocker arm.



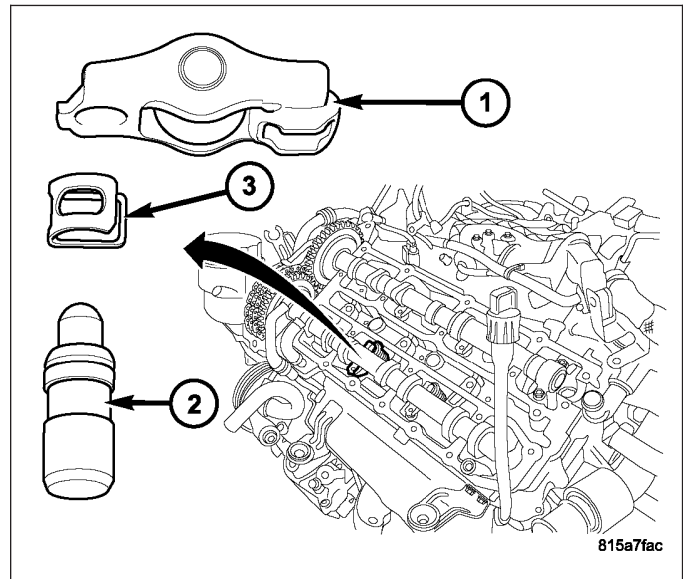
## INSPECTION

1. Clean each lifter assembly in cleaning solvent to remove all varnish and sludge deposits. Inspect for indications of scuffing on the side and base of each lifter body (2).
2. Squeeze the lifter and be sure that the spring returns the lifter to its correct position.
3. Inspect the retaining clip (3) and rocker arm (1) roller for damage or excessive wear.
4. Replace any worn or damaged components.



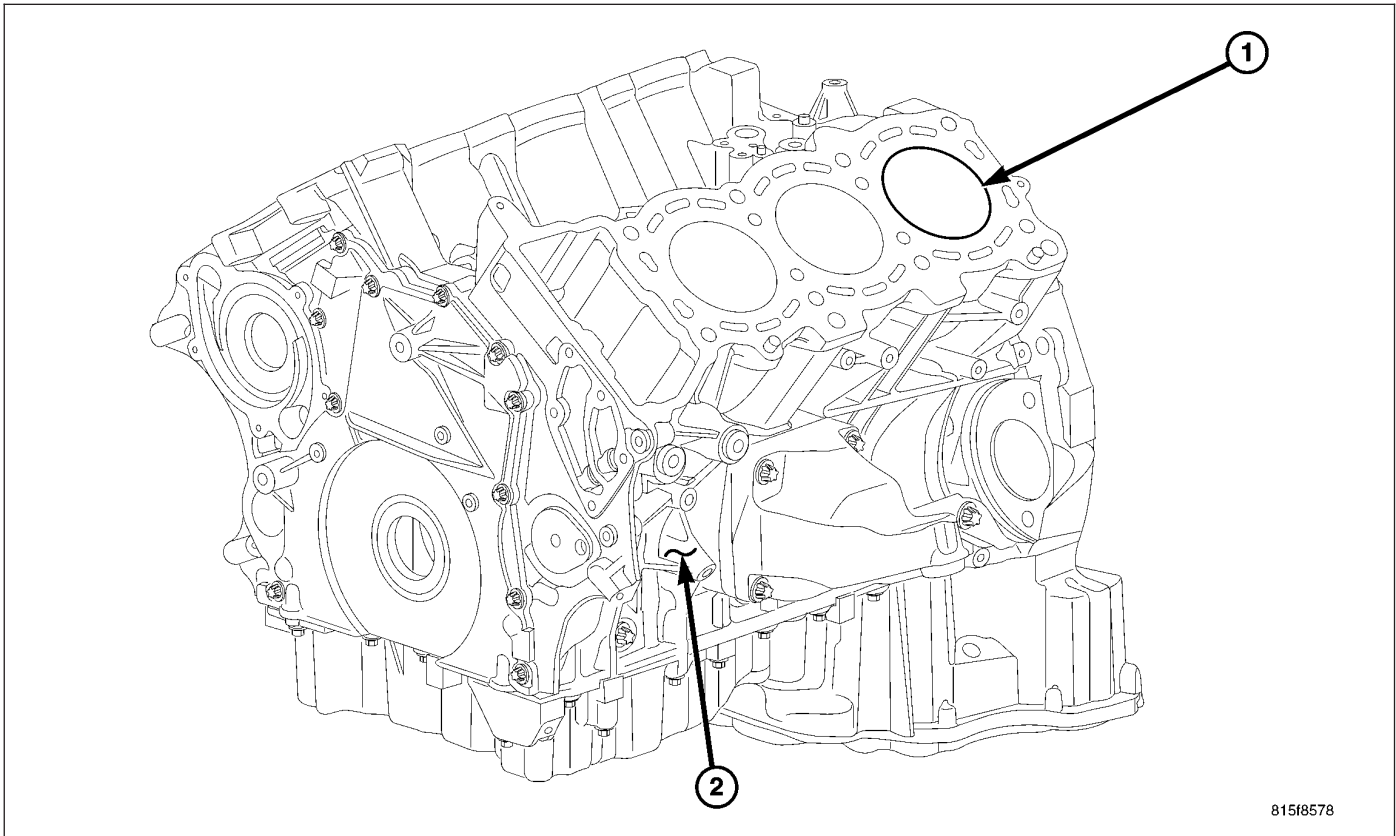
## INSTALLATION

1. Assemble the hydraulic lifter (2) to the rocker arm (1) with the retaining clip (3).
2. Install the rocker arm and lifter assembly onto the cylinder head.
3. Install the camshaft(s). (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - LEFT - INSTALLATION) or (Refer to 9 - ENGINE/CYLINDER HEAD/CAMSHAFT(S) - RIGHT - INSTALLATION).



## BLOCK-ENGINE

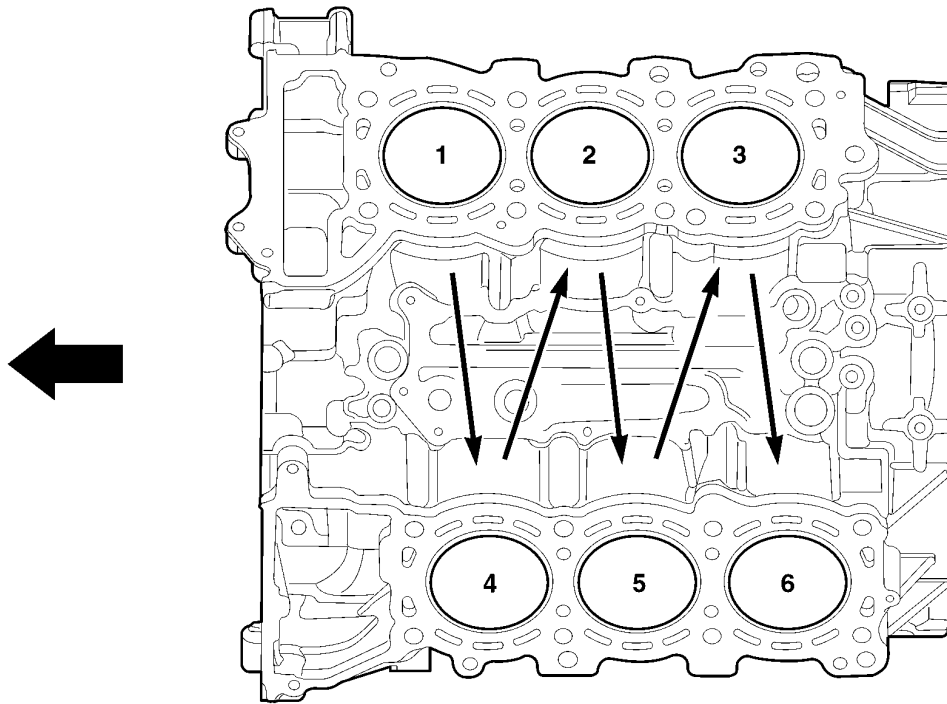
### DESCRIPTION



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The 3.0L engine utilizes a cast aluminum cylinder block (2) molded around cast iron piston sleeves (1). The cylinder angle is 72 degrees with cylinder spacing at 106 mm (4.173 in.). The cylinder block (2) has increased rigidity that reduces structural flexing, plus a fractured connecting rod cap design that can not distort connecting rod cap fit. The liner (1) surface is honed to a cross hatch angle between 40°-60°.

There is a stamped cylinder liner grading identification number located on the left front of the engine block, below the high pressure pump location. This identification mark (A, X, or B) is used for piston selection. For example, an "X" cylinder liner can use an "A", "X" or "B" piston. An "A" cylinder liner can only use an "A" or an "X" piston, and a "B" cylinder liner can only use a "X" or a "B" cylinder liner.



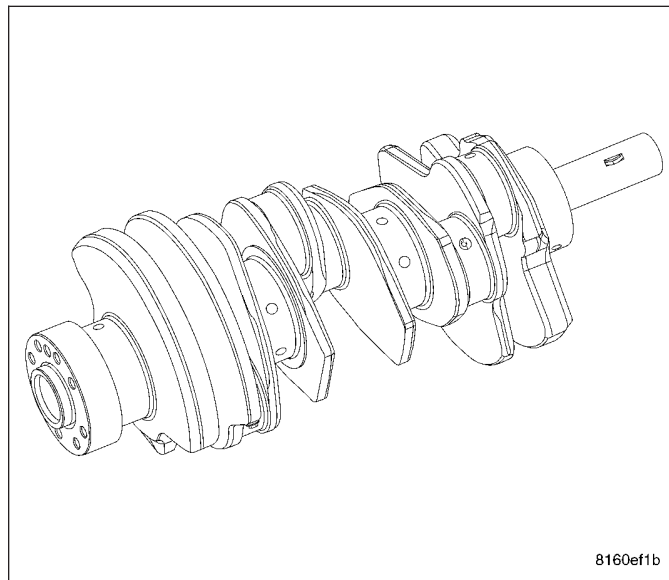
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Cylinders are numbered front to back, beginning with the right bank. The right bank cylinders are numbered 1, 2, 3. The left bank cylinders 4, 5, 6. The injection order of the engine is 1-4-2-5-3-6.

## CRANKSHAFT

### DESCRIPTION

The crankshaft (1) for the 3.0L is a forged steel type design with four main bearing journals. The third crankshaft support controls crankshaft thrust. The bearing identification for the upper crankshaft main journals is etched into the engine block below the high pressure pump and the proper lower bearing selection can be found etched in the front of the crankshaft.



### OPERATION

The crankshaft transfers force generated by combustion within the cylinder bores to the flexibility. The crankshaft has six separate throws arranged at different angles (splayed) to reduce second order free movements of inertia. Following the injection order 1-4-2-5-3-6, the crankshaft throw angles alternate between 48° and 192°.

In the injection order, together with the splayed throws and the 72° V-block, produce injection intervals of 120° (even fire). After ignition TDC of cylinder number 1, the crankshaft turns 120° to reach TDC of cylinder number 4. The 120° angle (even fire) is the result of the 48° throw angle plus the 72° cylinder block angle.

### STANDARD PROCEDURE

#### MEASURE CRANKSHAFT AND BLOCK JOURNALS

**NOTE:** After any bearing damage occurred, remove all debris which is present in the main oil gallery, connecting rod bores, and in the crankshaft and oil galleries. Include removal of the inserting steel ball of the main oil gallery before cleaning.

1. Remove crankshaft.
2. Clean all engine parts thoroughly.

**CAUTION:** Replace all of the connecting rods when ever any of the rod cap bolts are loosened or bearing caps are removed

3. Inspect crankshaft, replace as necessary.
4. Inspect crankcase for damage.
5. Inspect crankshaft main bearing caps for damage.
6. Install the crankshaft main bearing caps and check for out of round. Replace as necessary.
7. Remove the main bearing caps and install the crankshaft with the correct selected bearings.

**NOTE:** Radial mounting of the main bearings of standard size crankshaft is possible by assigning the color-coded bearing shells. The upper main bearings can be identified by the four digit mark etched on the engine block below the high pressure pump. The lower main bearings can be identified by the code etched on the front of the crankshaft hub.



## **ASSIGNING CRANKSHAFT MAIN BEARING SHELLS**

The upper main bearings can be identified by the four digit mark etched in the block below the high pressure pump. The lower main bearings can be identified by the code etched on the front of the crankshaft hub. This color code indicates which bearing shell halves are to be used.

8. Select the correct bearing shells based upon the crankcase and crankshaft identification marks.
9. Mount crankshaft axially using the thinnest thrust washer.
10. Inspect crankshaft end play. If the crankshaft end play is out of specification, remove the crankshaft and install the larger thrust shim. repeat the procedure until crankshaft end play is within specification.
11. Mount the crankshaft axially again and check each main bearing oil clearance with plasti-gauge. For bearing clearance specifications, (Refer to 9 - ENGINE - SPECIFICATIONS).

## **CHECKING CRANKSHAFT END PLAY**

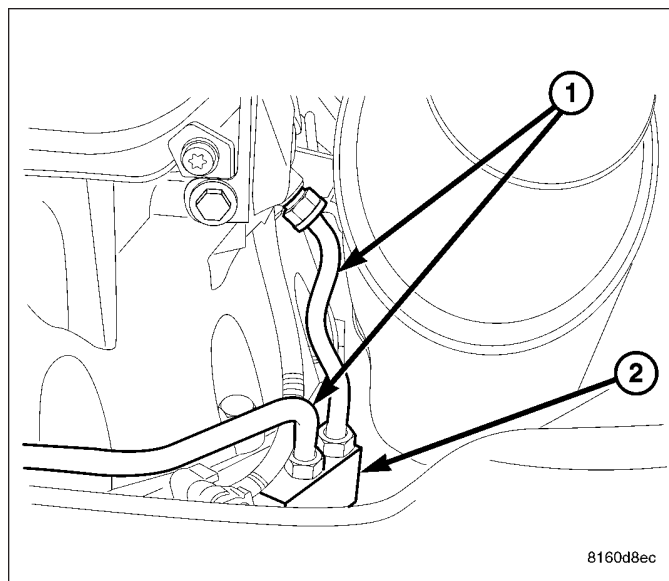
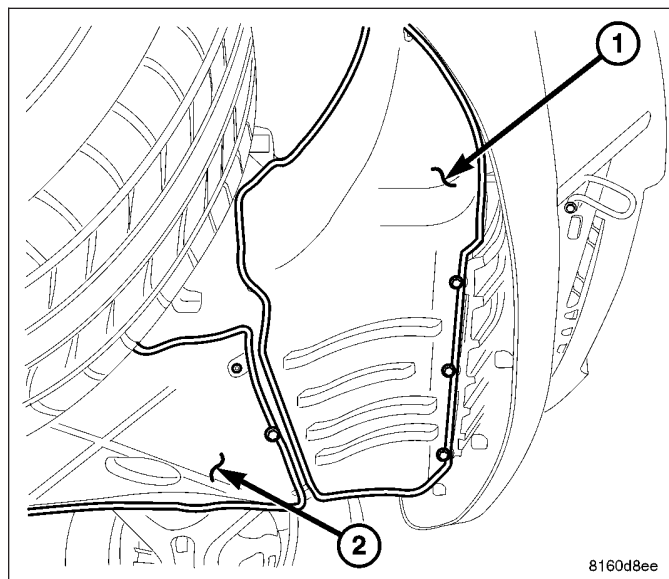
1. Mount a dial indicator to a stationary point at rear of engine. Locate the probe perpendicular against the rear of the crankshaft.
2. Move the crankshaft all the way to the front of its travel.
3. Zero the dial indicator.
4. Move the crankshaft all the way to the rear of its travel and record the reading on the dial indicator. For crankshaft end play clearances refer to the engine specification chart (Refer to 9 - ENGINE - SPECIFICATIONS).

The upper main bearings are available in three different thicknesses and the lower bearings in five. A color coded mark on the side of the bearing is used to identify it's thickness. Each color coded bearing is matched to it's respective journal. The select fit is obtained by matching the color coded bearings to grade identification marks on the cylinder block and crankshaft. Letters marked on the cylinder block identify the color of each upper-half main bearing, while letters marked on the front end of the crankshaft indicate the color of each lower half main bearing.

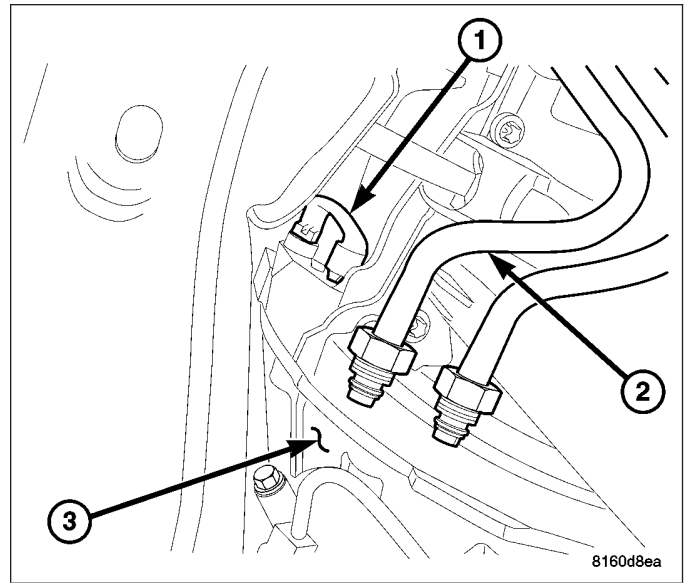
## SEAL - CRANKSHAFT OIL - FRONT

### REMOVAL

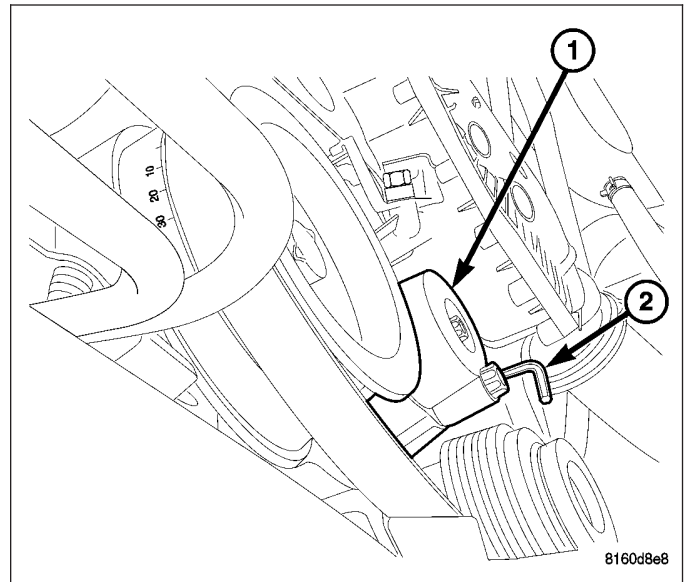
1. Disconnect negative battery cable.
2. Raise and support the vehicle.
3. Remove both front lower splash shields.
4. Remove the transmission thermal bypass valve and the cooler lines between the block and transmission.



5. Remove the starter blank.
6. Install special tool # 9102 crankshaft lock (1).



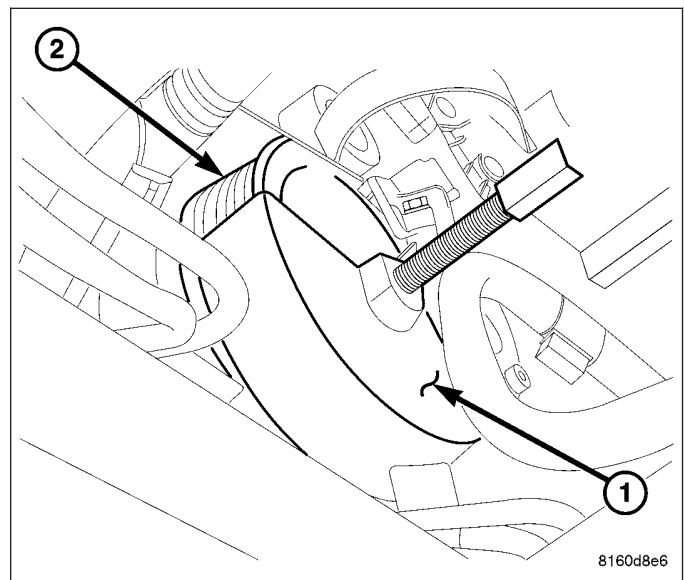
7. Release the accessory drive belt tension by resetting the drive belt tensioner and installing a retaining pin.



8. Remove the vibration damper bolt.
9. Install special tool #9544 (1) vibration damper puller.
10. Remove the vibration damper (2).

**CAUTION:** Care must be taken when removing the crankshaft seal. DO NOT damage or gouge the timing chain cover.

11. Using suitable seal puller, remove the front crankshaft seal.



## INSTALLATION

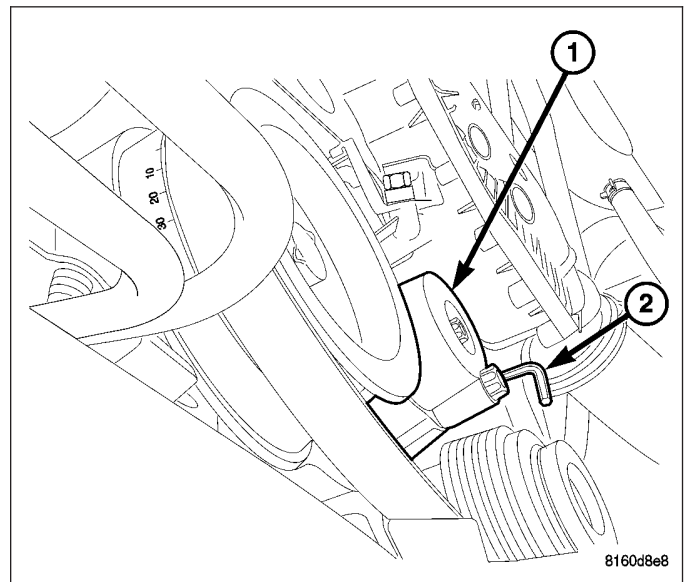
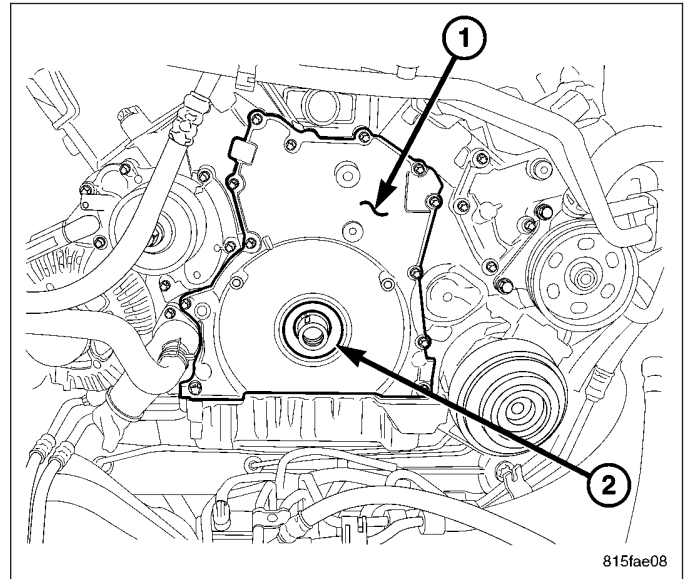
**NOTE:** To prevent potential oil leaks, **DO NOT** touch the front crankshaft inner seal. Always handle the seal from the outer diameter.

1. Clean timing chain cover (1) seal surface.

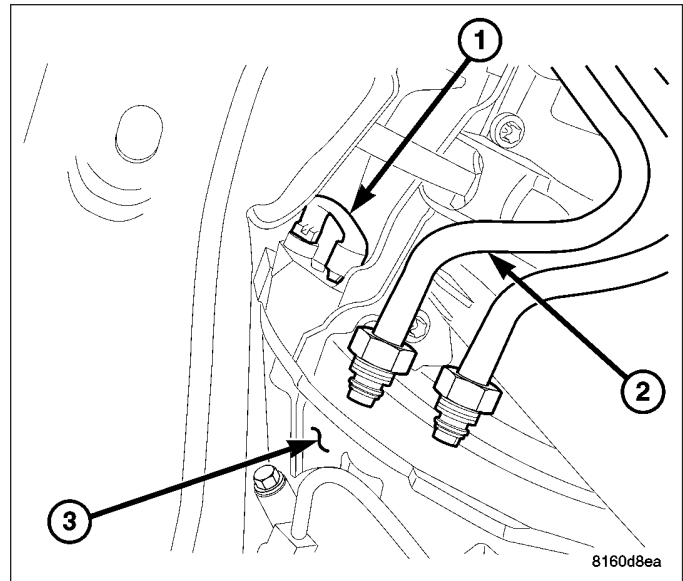
**NOTE:** Keep seal centered in the timing chain cover at all times.

2. Install crankshaft oil seal (2) using Installer 8936A.
3. Align the alignment key in the crankshaft with the key way in the damper and install the vibration damper. Torque bolt to 304 N·m, plus 90° (224 ft.lbs., plus 90°).

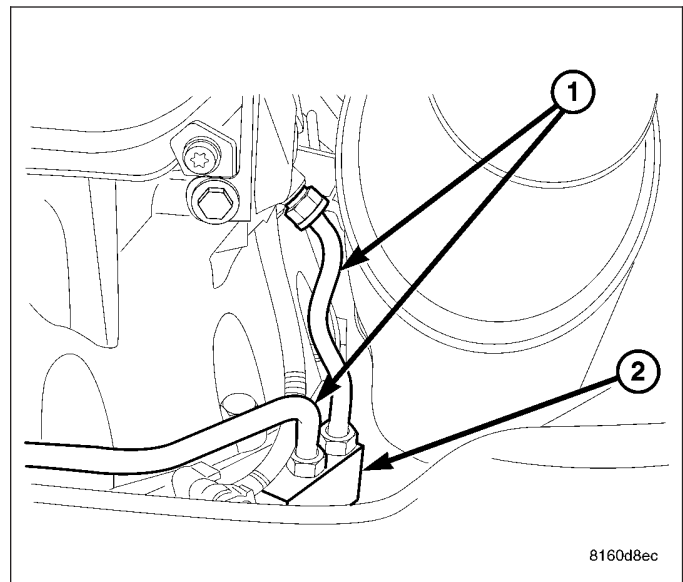
4. Position the drive belt back onto the pulleys and release the belt tensioner.



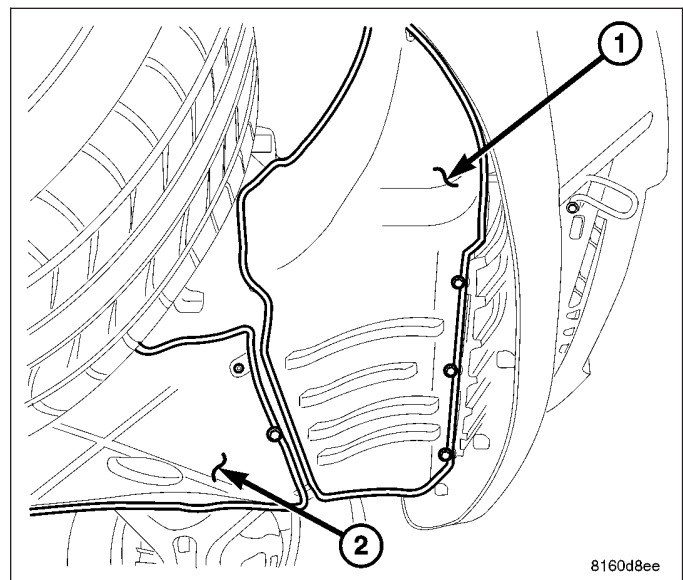
5. Remove special tool #9102 crankshaft lock (1).



6. Install the transmission thermal bypass valve (2) and transmission cooler lines (1).



7. Install the intermediate (2) and front (1) underbody splash shields.  
 8. Lower the vehicle.  
 9. Connect negative battery cable.



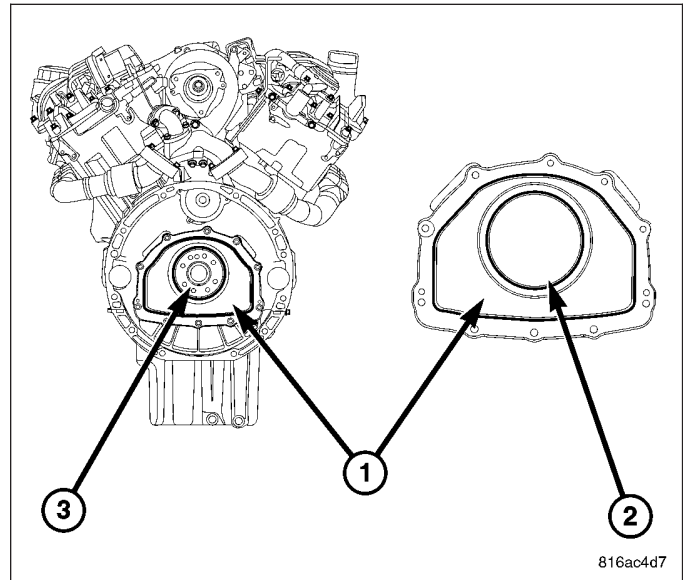
## SEAL-CRANKSHAFT OIL - REAR

### DESCRIPTION

The rear main seal carrier is located behind the flex plate. The main seal carrier is bolted to the cylinder block and oil pan. The rear main seal is molded to the carrier and is not serviceable. The rear main seal carrier must be replaced if an oil leak or seepage occurs.

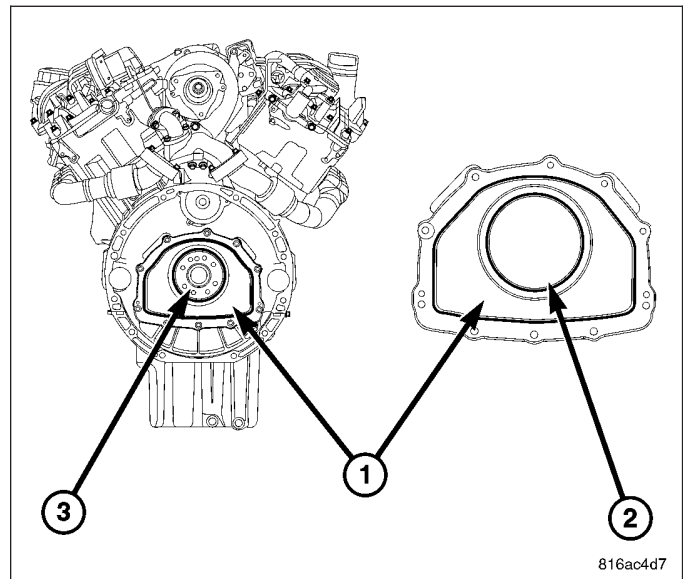
**WARNING: NOTE: When servicing the oil pan, the transmission and flex plate must be removed to access the rear main seal carrier fasteners.**

The rear main seal carrier (1) is located behind the flex plate. The rear main seal carrier is bolted to the cylinder block and oil pan. The rear main seal (2) is molded to the carrier and is not serviceable. The rear main seal carrier must be replaced if an oil leak or seepage occurs.



### REMOVAL

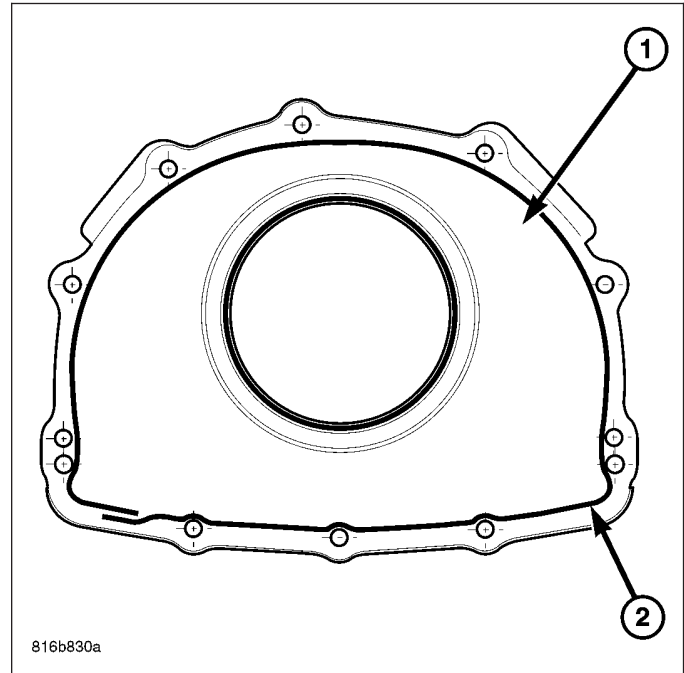
1. Remove the transmission. (Refer to 21 - TRANSMISSION/AUTOMATIC - NAG1 - REMOVAL)
2. Remove the bolts holding the driveplate to the crankshaft (3).
3. Remove the driveplate.
4. Remove the bolts holding the rear main seal carrier (1) to the engine block and oil pan.
5. Remove the rear main seal carrier (1) from the engine block and oil pan.
6. Clean sealant residue from the engine block and oil pan.



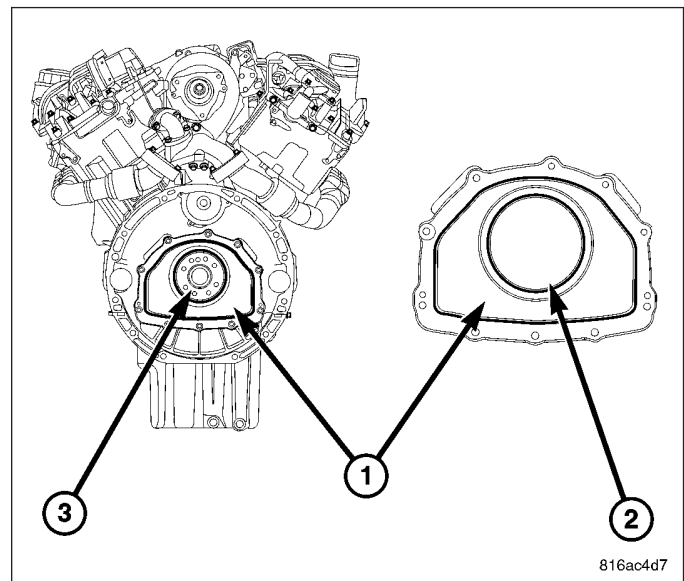


## INSTALLATION

1. Apply sealant 1.5 mm (.059 in) wide, MOPAR Engine Sealant / RTV Silicone Rubber Adhesive (2) to the rear main seal carrier (1). Install the rear oil seal cover within 10 minutes after applying sealing compound. Do not spread the sealing bead. Only use the approved sealing compound in the Service Information. Clean sealing surfaces and apply sealing compound to the marked line with a bead thickness of  $1.5 \pm 0.5$  mm ( $0.059 \pm 0.020$  in.).



2. Install the rear main seal carrier (1) to the engine block and oil pan.
3. Install the bolts holding the rear main seal carrier (1) to the engine block and oil pan. Torque the bolts to 9 N·m (7 ft. lbs.).
4. Install the driveplate. Torque bolts to 45 N·m (33 ft. lbs.) plus an addition 90°.
5. Install the transmission. (Refer to 21 - TRANSMISSION/AUTOMATIC - NAG1 - INSTALLATION).

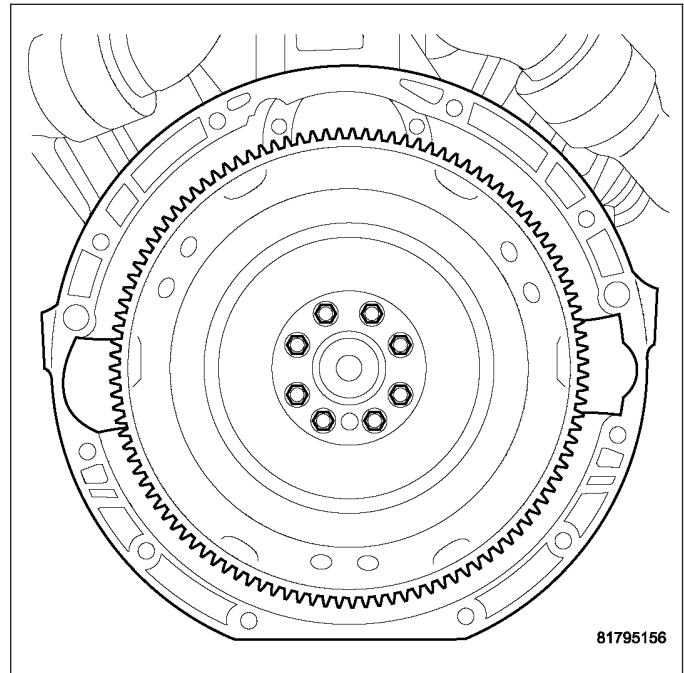


## FLEXPLATE

### DESCRIPTION

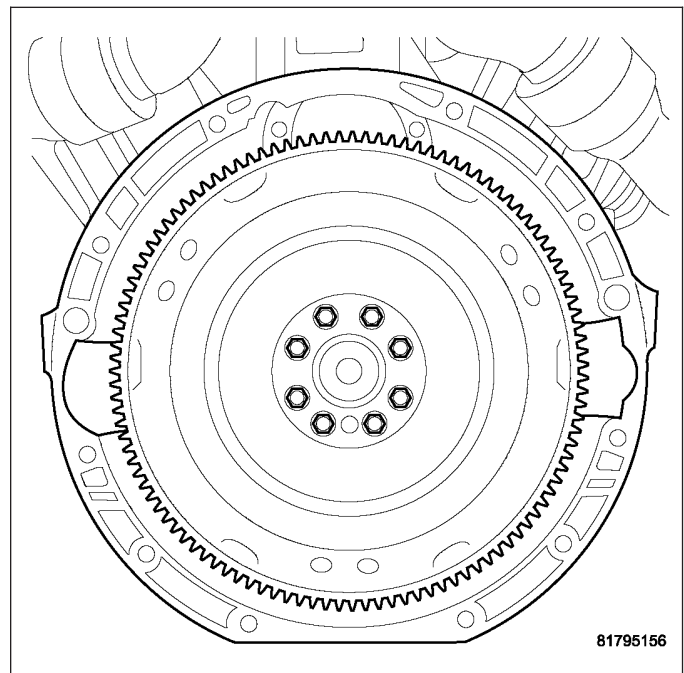
The flex plate is fastened to the crankshaft and can only be installed one way. The crankshaft has a dowel locating pin that is used to align the flex plate. The stamped-steel flex plate has a segment ring to provide engine speed and crankshaft position information to the Engine Control Module (ECM). The crankshaft position sensor is mounted next to the segment ring and sends electrical pulses to the ECM. The segment ring contains 58 segments and a gap with two missing segments (the 59th and 60th) for the detection of TDC of cylinder No.1.

**WARNING:** The flex plate bolts are microencapsulated and must always be replaced.



### REMOVAL

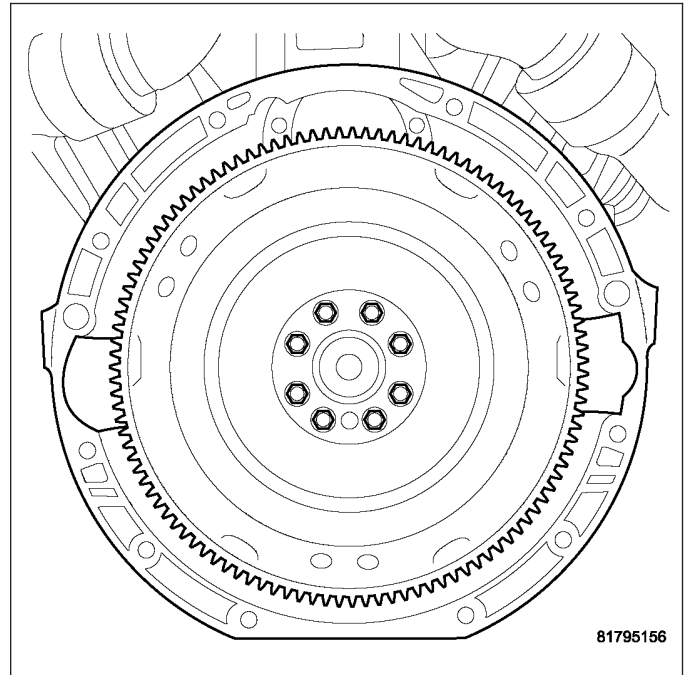
1. Remove the transmission (Refer to 21 - TRANSMISSION/AUTOMATIC - NAG1 - REMOVAL).
2. Paint mark the flex plate hub to flex plate relation.
3. Remove the flex plate bolts and flex plate.
4. Inspect flex plate for damage.



## INSTALLATION

**NOTE:** Do Not lubricate new bolts as they are already coated with an anti-scuff treatment. Align the flex plate to hub paint marks, where applicable.

1. Install the flex plate hub and hand tighten the fasteners.
2. Tighten each flex plate hub fastener to 50 N·m (37 lbs. ft.) in a clockwise cross sequence.
3. At this point, loosen one flex plate adaptor fastener, and with a torque wrench and angle gauge, tighten the fastener to 25 N·m (19 lbs. ft.), plus 60°.
4. Perform the above procedure for the remaining flex plate adaptor bolts in a clockwise cross sequence.
5. Install the flex plate locating pin.
6. Install the flex plate to the hub and install the fasteners. Tighten the flex plate fasteners in a cross sequence to 44 N·m (32.5 ft. lbs.).
7. Install the transmission (Refer to 21 - TRANSMISSION/AUTOMATIC - NAG1 - REMOVAL).



## LINERS-CYLINDER

### DESCRIPTION

The cylinder liners used in the 3.0L engine are made of cast iron and molded into the aluminum engine block. There are three size cylinder liners used and they are identified by the markings "A", "X", or "B" on the engine block below the high pressure pump. These markings are used to match piston size with cylinder bore size.

A group of letters located on the machined surface of the cylinder block, above the engine identification number, identifies the dimensional tolerance of each cylinder bore. The standard diameter of the cylinder bore is 83.009 mm (3.2681 in). The manufacturing tolerance is  $\pm 0.009$  mm ( $\pm 0.00035$  in). Three cylinder bore groups are assigned within the 0.018 mm (0.0007 in) tolerance:

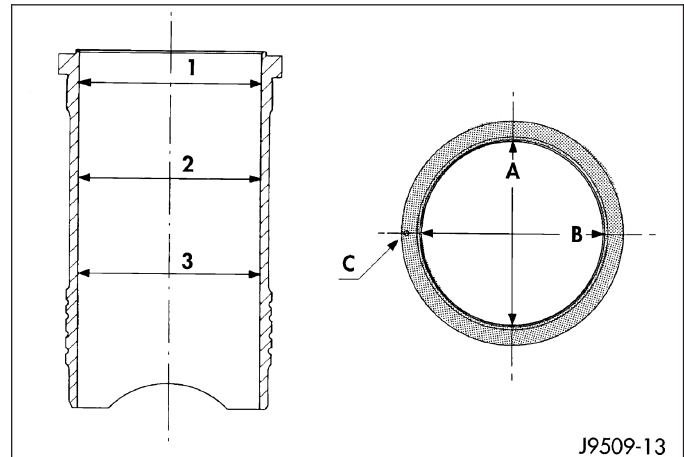
- Code letter A—includes cylinder bore sizes 83.000-83.006 mm (3.2677-3.2680 in)
- Code letter X—includes cylinder bore sizes 83.006-83.012 mm (3.2680-3.2682 in)
- Code letter B—includes cylinder bore sizes 83.012-83.018 mm (3.2682-3.2684 in)

**WARNING:** The cylinder liners are not serviceable and no repair stages are specified. Oversize pistons are not available. The cylinder block must be replaced if a cylinder liner is out of specifications.

### INSPECTION

The cylinder walls should be checked for out-of-round and taper with a dial bore gauge. If the cylinder walls are badly scuffed or scored, replace the engine block.

Measure the cylinder bore at three levels in directions A and B. Top measurement should be 10 mm (3/8 in.) down and bottom measurement should be 10 mm (3/8 in.) up from the bottom bore.



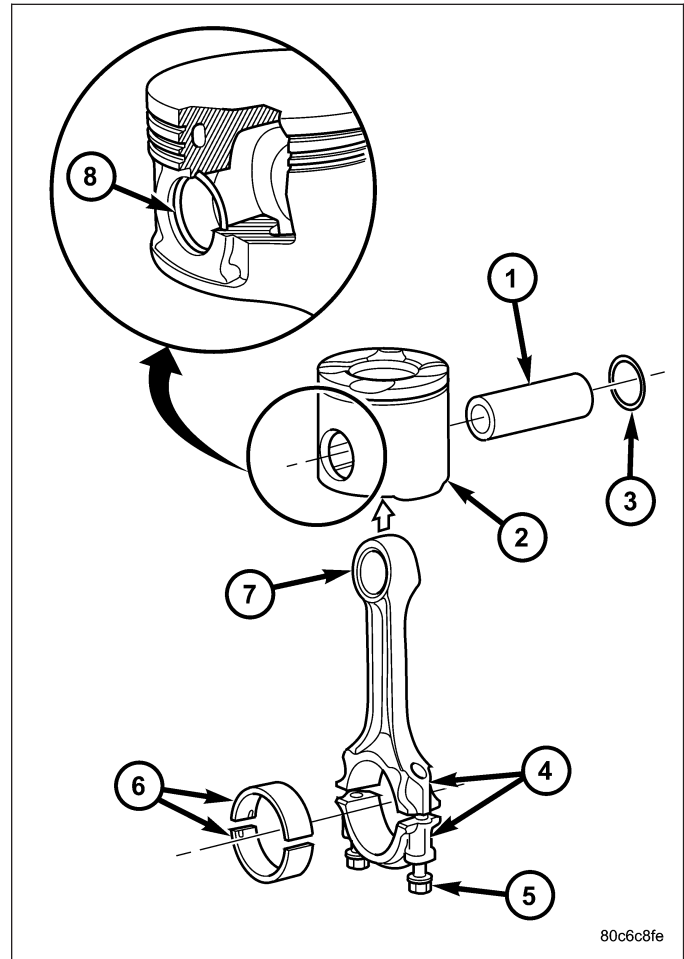
## ROD-PISTON AND CONNECTING

### DESCRIPTION

**CAUTION:** If the connecting rod bolts are ever loosened, replace all of the connecting rods.

**NOTE:** Slight bluing or heat transfer witness marks around the connecting rod caps and crankshaft journal is normal. This is part of the heat treating process from the factory and Does Not indicate premature bearing failure.

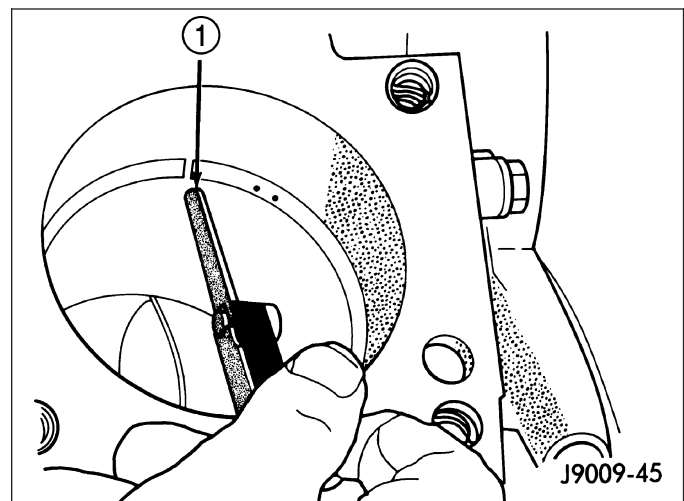
The pistons (2) are of a free floating design. Oil jets in the engine block lubricate and cool the piston (2) and pin (1) assembly. The connecting rods (7) have a pressed in place wrist pin bushing which is lubricated by the oil jets. Piston rod and bearing caps have cracked mating surfaces and are not interchangeable.



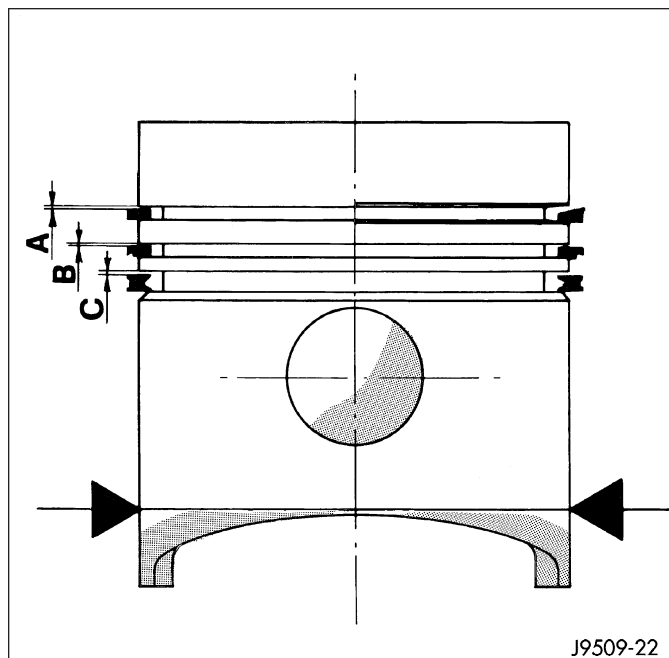
### STANDARD PROCEDURE

#### PISTON RING FITTING

1. Wipe cylinder bore clean. Insert ring and push down with piston to ensure it is square in bore. The ring gap measurement must be made with the ring positioning at least 12 mm (0.50 in.) from bottom of cylinder bore. Check gap with feeler gauge (1). Top compression ring gap .40 to .55mm (.015in to .0217 in.). Second compression ring gap .25mm to .50mm (.0099 to .0197 in.). Oil control ring gap .20 to .40mm (.0079 to .0158 in.).
2. If ring gaps exceed dimension given, new rings, piston and cylinder boring may be necessary. Keep piston rings in piston sets.



3. Check piston ring to groove clearance. Top compression ring gap 0.12 to 0.16 mm (.0048 to .0063 in.) (A). Second compression ring gap 0.065 to 0.110 mm (.0026 to .0044 in.) (B). Oil control ring gap 0.03 to 0.07 mm (.0012 to .0028 in.) (C).



## REMOVAL

**NOTE:** Both the connecting rod and the connecting rod cap are paint marked to aid during assembly. Paint marks disappear after time. If the rod and the cap are not marked with paint, paint mark or scribe them before disassembly.

1. Disconnect negative battery cable.
2. Remove cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).
3. Raise vehicle on hoist.
4. Remove oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).
5. Remove oil pump pickup tube. (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL)
6. Remove balance shaft assembly (Refer to 9 - ENGINE/VALVE TIMING/BALANCE SHAFT - REMOVAL).
7. Remove top ridge of cylinder bores with a ridge reamer before removing pistons from cylinder block. **Be sure to keep top of pistons covered during this operation.**
8. Piston and connecting rods must be removed from top of cylinder block. Rotate crankshaft so that each connecting rod is centered in cylinder bore.

**NOTE:** Be careful not to nick or scratch crankshaft journals

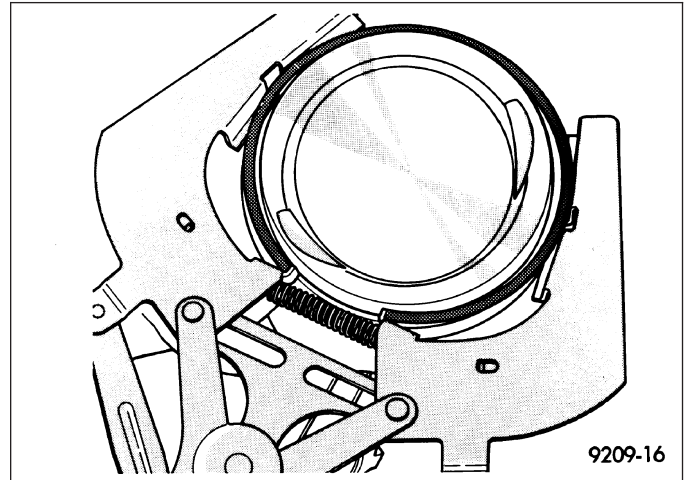
9. After removal, install bearing cap on the mating rod and mark pistons with matching cylinder number when removed from engine block.

## PISTON PIN - REMOVAL

1. Secure connecting rods in a soft jawed vice.
2. Remove 2 snap rings securing piston pin.
3. Push piston pin out of piston and connecting rod.

## PISTON RING - REMOVAL

1. ID mark on face of top and second piston rings must point toward piston crown.
2. Using a suitable ring expander, remove top and second piston rings.
3. Remove upper oil ring side rail, lower oil ring side rail and then the oil expander from piston.
4. Carefully clean carbon from piston crowns, skirts and ring grooves ensuring the 4 oil holes in the oil control ring groove are clear.



## INSPECTION

### PISTONS

1. Check piston pin bores in piston for roundness. Make 3 checks at 120° intervals. Maximum out of roundness .020 mm (.0008 in.).
2. The piston diameter should be measured approximately 10mm (.394 in.) up from the base.
3. Skirt wear should not exceed 0.1 mm (.00039 in.).
4. The clearance between the cylinder liner and piston should not exceed 0.010-0.022 mm (.0003 -.0008 in.).

### PISTON PINS

1. Measure the diameter of piston pin in the center and both ends. Refer to the engine specification chart (Refer to 9 - ENGINE - SPECIFICATIONS).

### CONNECTING RODS

**CAUTION:** Connecting rods must be replaced once the end caps are loosened. All six must have the same weight and the same number. Replacement connecting rods will only be supplied in sets of six. When assembling the connecting rod, be sure to paint mark or scribe mark each of the connecting rods and caps before installation, for alignment purposes later.

**NOTE:** Do Not lubricate the new connecting rod bolts. They are already coated with a anti scuff treatment.

Connecting rods are supplied in sets of six since they all must be of the same weight category. Max allowable weight difference is 5 gr.

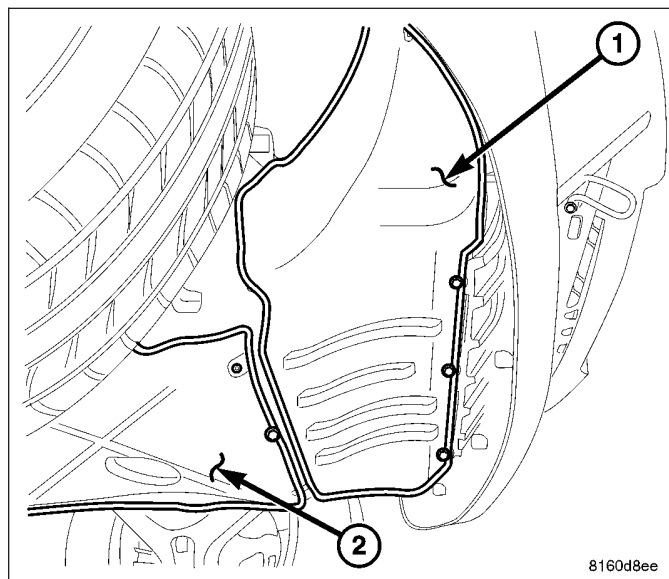
1. Assemble bearing shells and bearing caps to their respective connecting rods ensuring that the serrations on the cap and reference marks are aligned.
2. Tighten connecting cap bolts to 20 N·m (15 ft. lbs.).
3. Without loosening connecting rod bolts, tighten all bolts to 40 N·m (30 ft.lbs.).
4. Using a torque angle gauge, tighten each bolt an additional 90°.



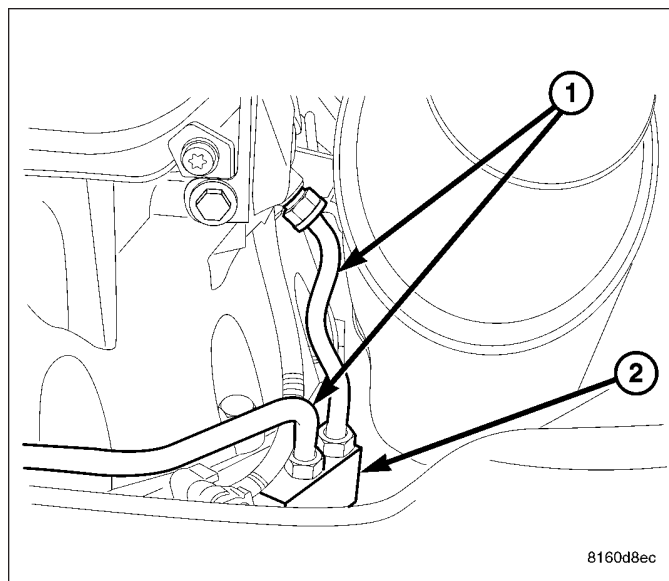
## DAMPER-VIBRATION

### REMOVAL

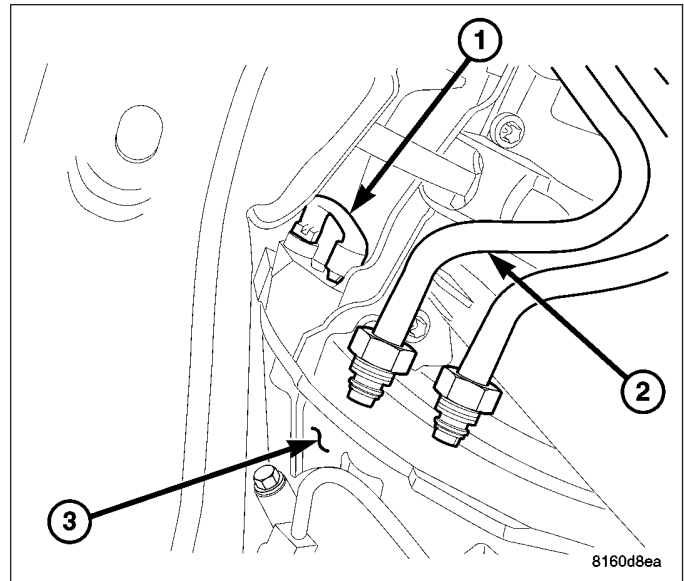
1. Disconnect negative battery cable.
2. Raise and support the vehicle.
3. Remove both front lower splash shields (1,2).



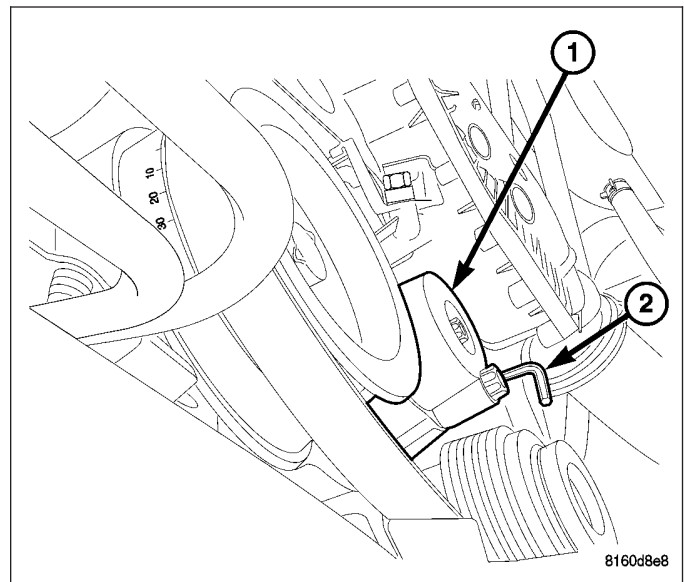
4. Remove the transmission thermo-block (2), and the cooler lines (1) between the block (2) and transmission.



5. Remove the starter blank.
6. Install special tool # 9102 crankshaft lock (1).



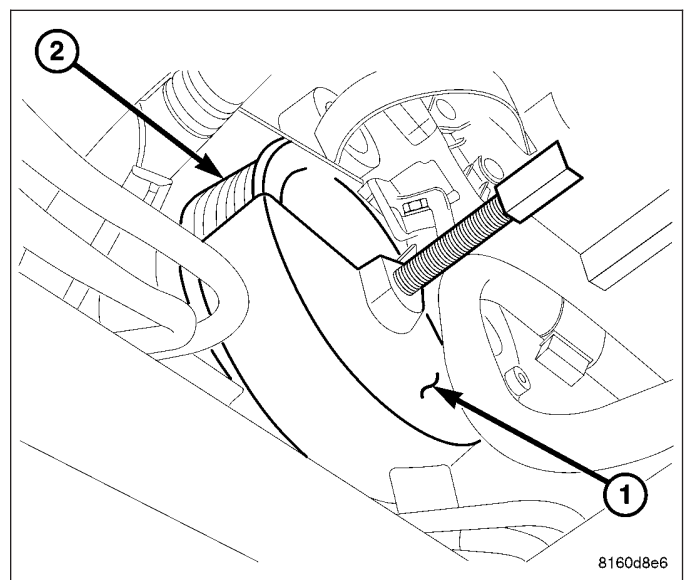
7. Release the accessory drive belt tension by resetting the drive belt tensioner (1) and installing a retaining pin.



8. Remove the vibration damper (2) bolt.
9. Install special tool #9544 vibration damper puller (1).

**CAUTION:** Care must be taken when removing the damper. DO NOT damage or gouge the front crankshaft seal

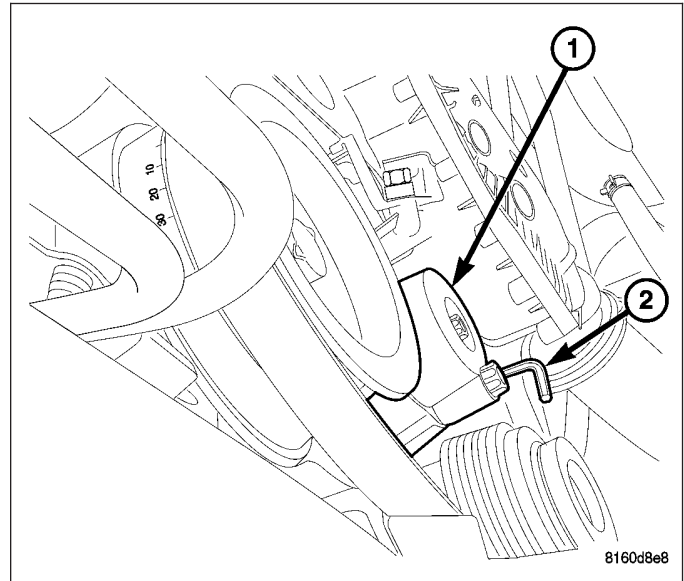
10. Remove the vibration damper (2).



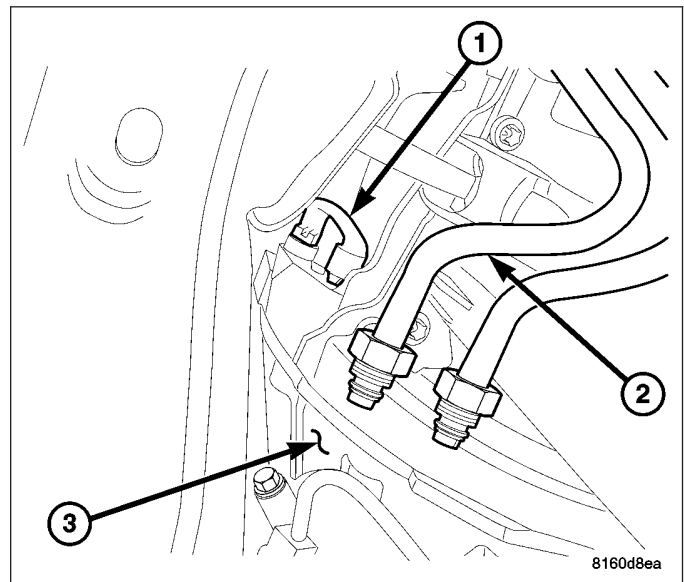
## INSTALLATION

**NOTE:** To prevent potential oil leaks, **DO NOT** touch the front crankshaft inner seal.

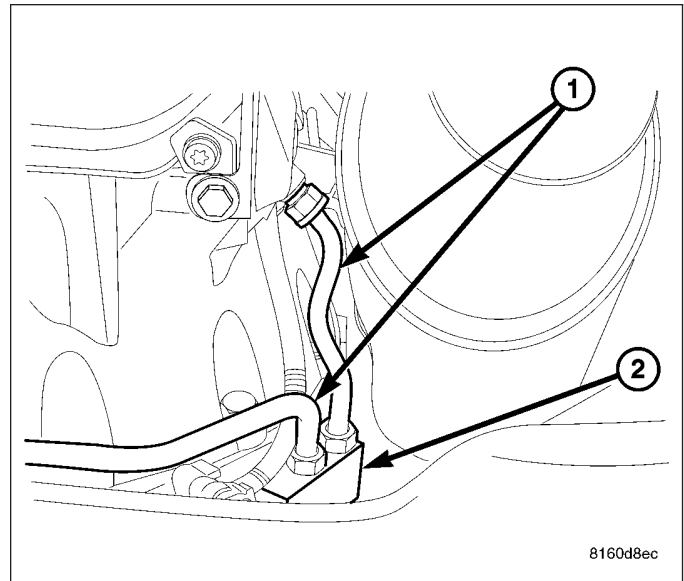
1. Align the alignment key in the crankshaft with the key way in the damper and install the vibration damper. Torque bolt to 304 N·m, plus 90° (224 ft. lbs., plus 90°).
2. Position the drive belt back onto the pulleys and release the belt tensioner (1).



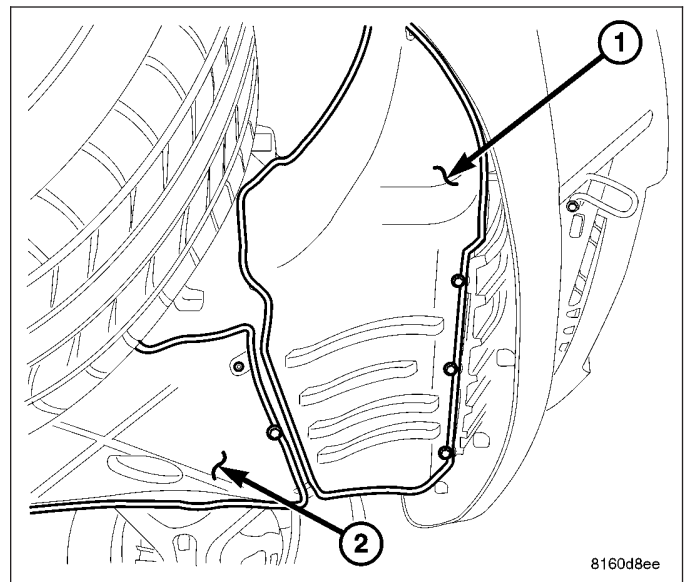
3. Remove special tool #9102 crankshaft lock (1).



4. Install the transmission thermal bypass valve (2) and transmission cooler lines (1).



5. Install the intermediate (2) and front (1) underbody splash shields.
6. Lower the vehicle.
7. Connect negative battery cable.



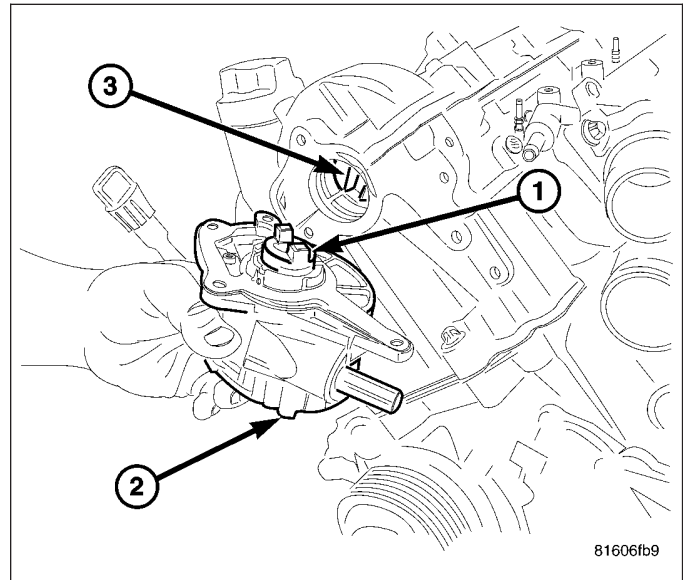
## PUMP-VACUUM

### DESCRIPTION

The vacuum pump is a constant displacement, vane-type pump. Vacuum is generated by vanes mounted in the pump rotor. The rotor is located in the pump housing and is pressed onto the pump shaft.

The vacuum pump operates by a slotted extension attached to the vacuum pump shaft. The vacuum pump shaft slotted extension fits into, and is driven by, the exhaust camshaft gear.

The vacuum pump rotating components are internally lubricated and the vacuum pump has no serviceable parts. Do not disassemble or attempt to repair the pump.

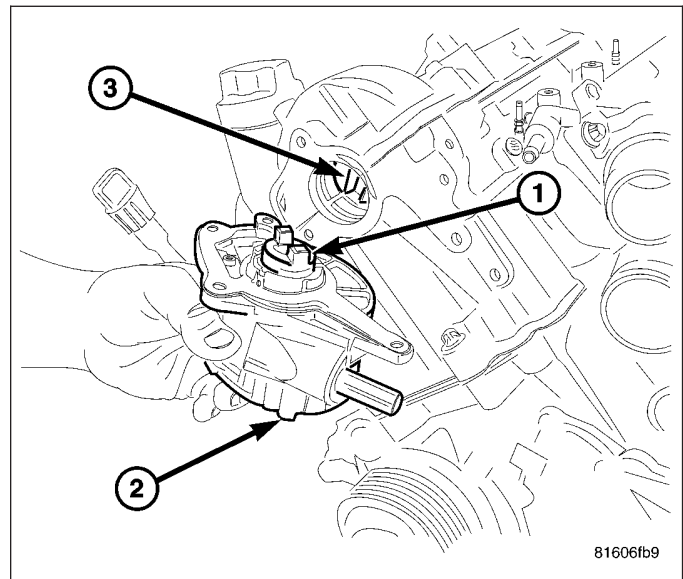


### OPERATION

Vacuum pump output is transmitted to the Heater, Electronic, Vacuum, Air Conditioner (HEVAC) and brake vacuum booster, systems through a supply hose. The hose is connected to an outlet port on the pump housing and uses an in-line check valve to retain system vacuum when vehicle is not running.

Pump output ranges from a minimum of 8.5 to 25 inches vacuum.

The pump rotor and vanes are rotated by the slotted pump drive gear which fits into the camshaft drive gear.

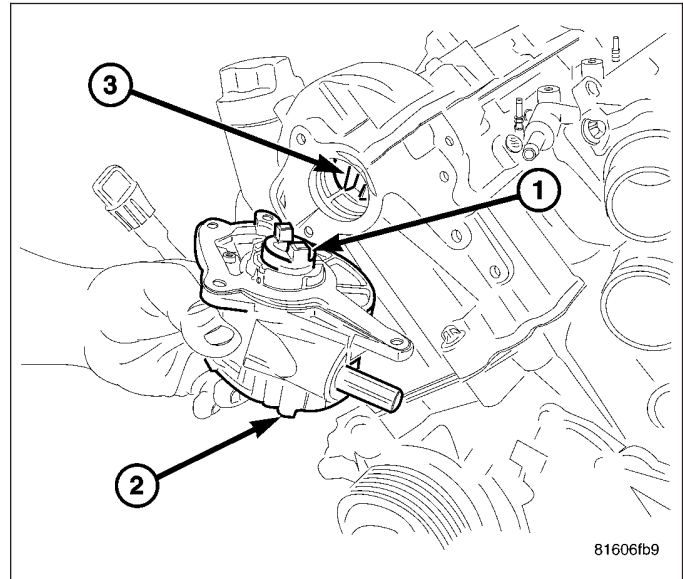


## REMOVAL

1. Disconnect negative battery cable.
2. Remove vacuum line at vacuum pump.

**NOTE:** Observe position of driver on rear of pump.

3. Remove vacuum pump and seals.
4. Clean all sealing surfaces.

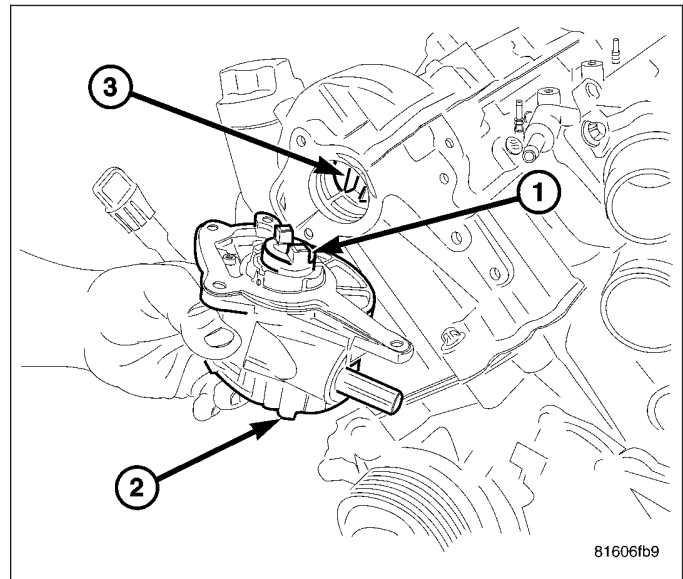


## INSTALLATION

1. Clean all sealing surfaces.
2. Position driver on rear of pump and install vacuum pump with new seals. Tighten bolts to 14 N·m (124 lbs. in.).
3. Install vacuum line to vacuum pump.
4. Connect negative battery cable.

**WARNING:** Use Extreme Caution When The Engine Is Operating. Do Not Stand In A Direct Line With The Fan. Do Not Put Your Hands Near The Pulleys, Belts Or Fan. Do Not Wear Loose Clothes.

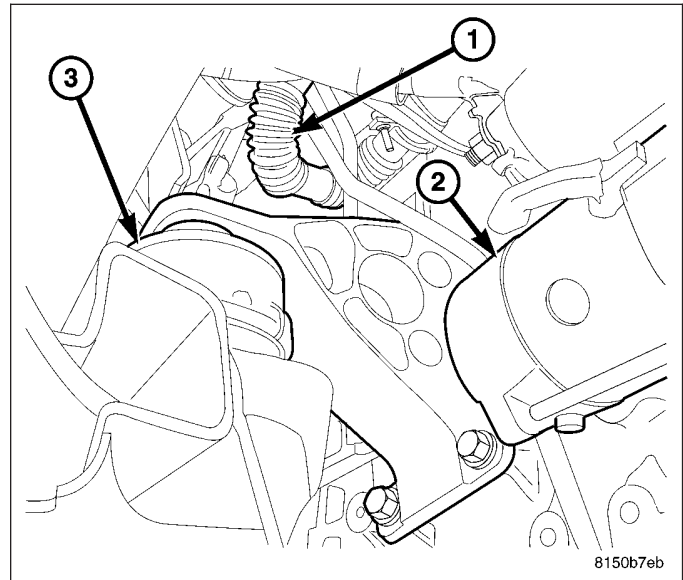
5. Start the engine and inspect for leaks.



## MOUNT-LEFT

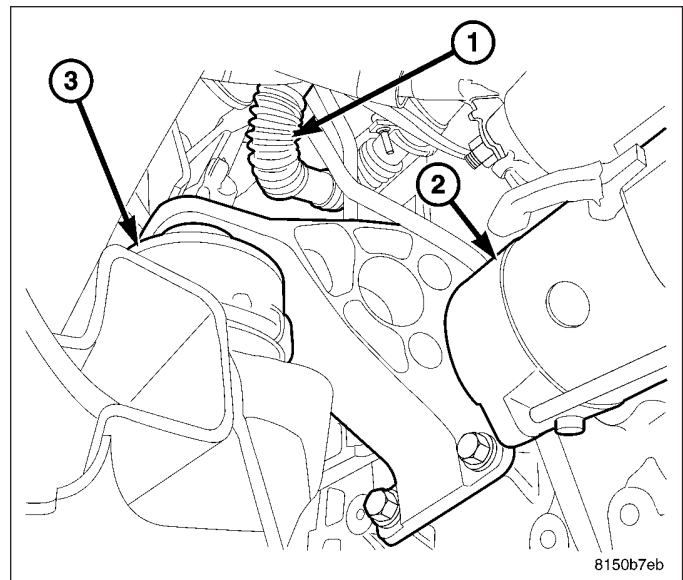
### REMOVAL

1. Disconnect the negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Remove the engine cover. (Refer to 9 - ENGINE - REMOVAL)
3. Remove the engine cover brackets and transmission tube retainer.
4. Remove the battery and battery tray.
5. Remove power distribution center (PDC) from bracket and set aside.
6. Remove PDC bracket.
7. Reposition engine wiring harness.
8. Raise and support the vehicle.
9. Loosen both right and left engine mount through bolts.
10. Lower the vehicle.
11. Install clevis brackets through engine lifting fixtures.
12. Install engine lifting chain to clevis brackets.
13. Install engine lift and hoist engine.
14. Remove the left engine mount retaining bolts.
15. Remove the engine mount.



### INSTALLATION

1. Position the engine mount, install the bolts and tighten the retaining bolts to 20 N·m (15 ft. lbs.) and then an additional 90°.
2. Lower the engine and remove the engine hoist with chain.
3. Raise and support the vehicle.
4. Install the engine mount through bolts. Tighten bolts to 110 N·m (82 lbs. ft.).
5. Install the splash shield.
6. Lower the vehicle.
7. Install the power distribution center (PDC) bracket and PDC.
8. Install the battery tray and battery.
9. Install the engine cover bracket and secure the transmission tube.
10. Install the engine cover front bracket.
11. Install the engine cover.
12. Install the front structural bracket.
13. Install the coolant recovery container.
14. Connect the negative battery cable.





## MOUNT-RIGHT

### REMOVAL

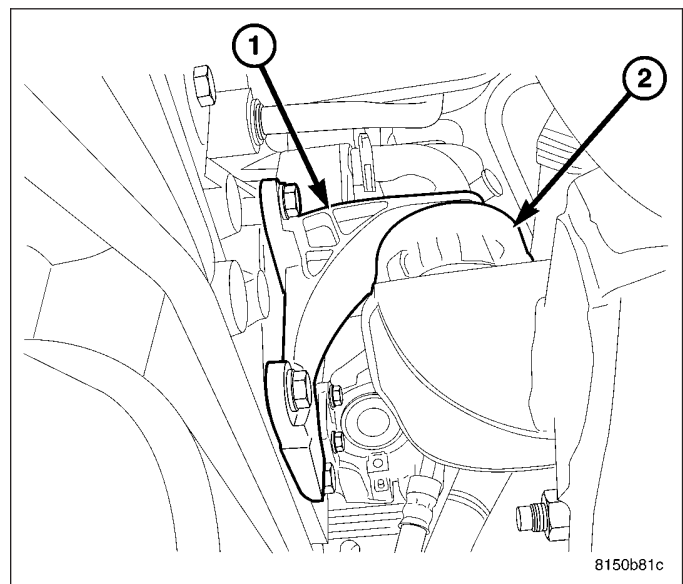
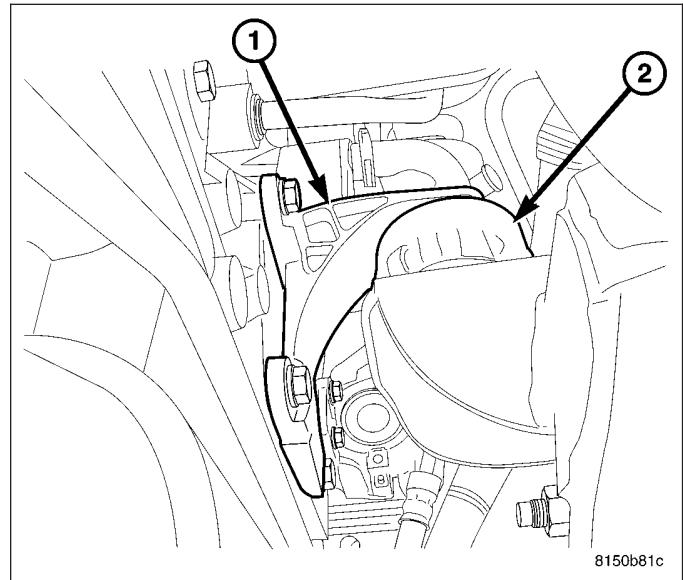
1. Disconnect the negative battery cable.
2. Remove the engine cover.
3. Remove the front engine cover bracket.
4. Separate the transmission level indicator tube from bracket and remove the rear engine cover bracket.
5. Install clevis bracket to engine lift brackets.
6. Install engine lifting chain through clevis brackets.
7. Raise and support the vehicle.
8. Remove the skid plate.
9. Drain engine oil.
10. Loosen both engine mount through bolts.
11. Lower the vehicle.
12. Remove the oil level indicator tube.

**NOTE:** Care must be taken not to crush the turbo-charger against the windshield cowl when raising and supporting the engine.

13. Connect an engine lift and support the engine.
14. Remove the engine mount retaining bolts.
15. Remove the engine mount.

### INSTALLATION

1. Position and install the engine mount to engine bolts. Tighten bolts to 45N·m (33 lbs. ft.).
2. Lower the engine and remove the lifting fixtures.
3. Install the oil level indicator tube.
4. Raise and support the vehicle.
5. Tighten the engine mount through bolts to 110 N·m (81 ft. lbs.).
6. Install the skid plate.
7. Lower the vehicle.
8. Install the rear engine cover bracket and secure the transmission level indicator tube.
9. Install the front engine cover bracket.
10. Fill the engine with the correct viscosity oil to the proper level.
11. Connect the negative battery cable.
12. Install the engine cover.



## LUBRICATION

### DESCRIPTION

An efficient and acoustically optimized chain drive external gear pump is used for supply.

Oil is circulated through a high volume primary oil filter on the engine to one of the oil/water coolers in the "V" of the engine. The oil cooler maintains a maximum oil temperature of 140° C (284°F).

After the oil cooler, the oil is directed into the balance shaft tunnel that at the same time is the primary oil duct of the crankcase. Short passages lead to the crankshaft main bearings. The inlet pressurized piston oil injectors are located directly on the main oil channel and are supplied there.

Front mounted passages supply the cylinder heads. The hydraulically loaded chain tensioner is supplied via the right cylinder head in the direction of travel.

The oil supply and return of the turbo charger is integrated in the cast steel turbo charger carrier.

## OIL

### DESCRIPTION

Refer to the Lube and Maintenance section for oil specifications (Refer to LUBRICATION & MAINTENANCE/FLUID TYPES - DESCRIPTION).

## **FILTER-OIL**

### **REMOVAL**

1. Using special tool 9551, unscrew the oil filter cap.
2. Remove clean and inspect cap gasket, replace as necessary.
3. Remove and discard the oil filter.

### **INSTALLATION**

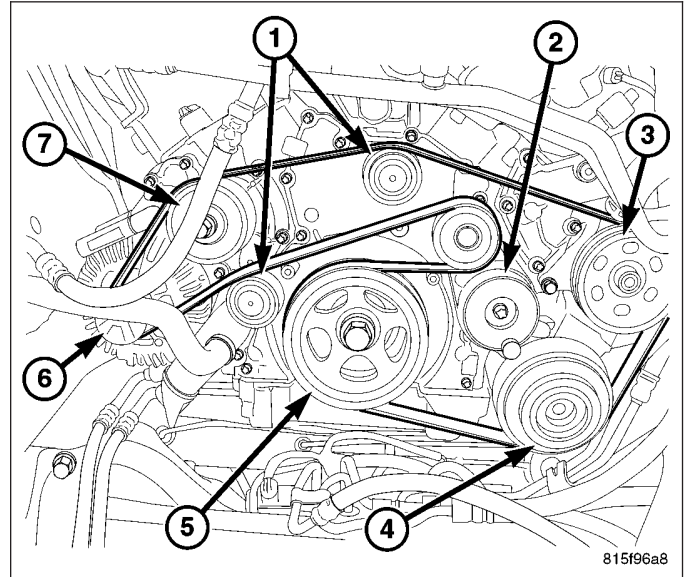
1. Inspect oil filter cap gasket, lubricate with clean engine oil.
2. Install oil filter.
3. Screw oil filter cap to housing and tighten to 25 N·m (18 lbs. ft.) using special tool 9551. Adjust oil level as necessary.

## PAN-OIL

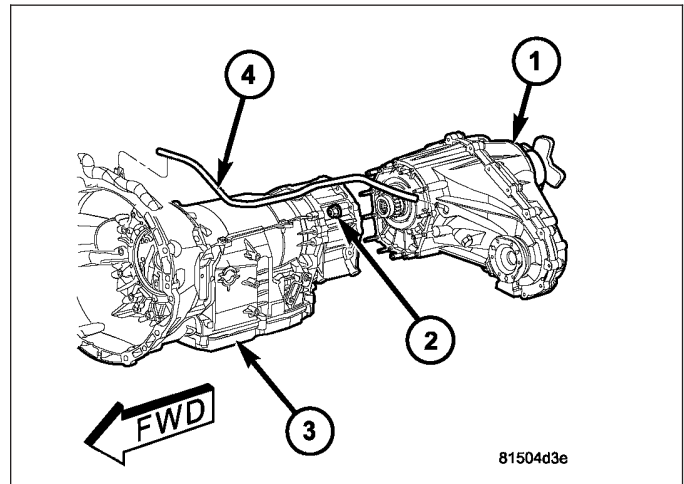
### REMOVAL

#### OIL PAN

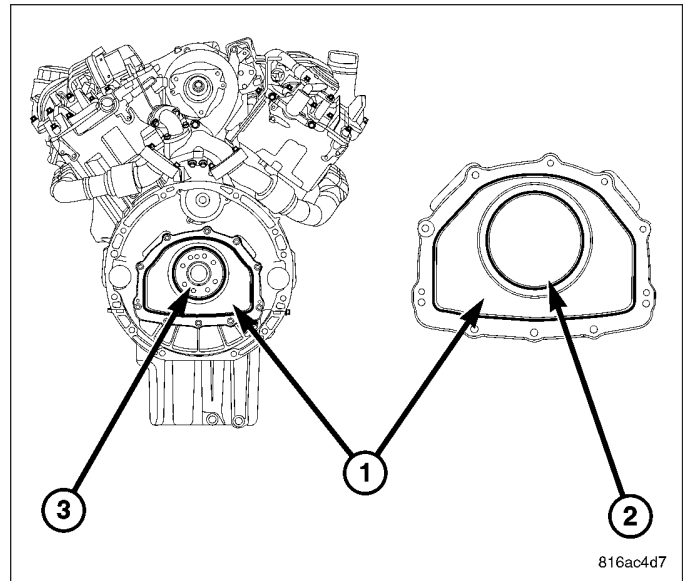
1. Disconnect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Remove the accessory belt.



3. Remove the transfer case. (Refer to 21 - TRANSMISSION/TRANSAXLE/TRANSFER CASE - DESCRIPTION)
4. Remove the transmission. (Refer to 21 - TRANSMISSION/TRANSAXLE/AUTOMATIC - NAG1 - REMOVAL)
5. Remove the A/C compressor and position aside.



6. Remove the flex plate. (Refer to 9 - ENGINE/ENGINE BLOCK/FLEX PLATE - REMOVAL)
7. Remove the 5 bolts on the bottom of the rear main seal carrier.
8. Remove oil pan bolts.
9. Remove the oil pan.



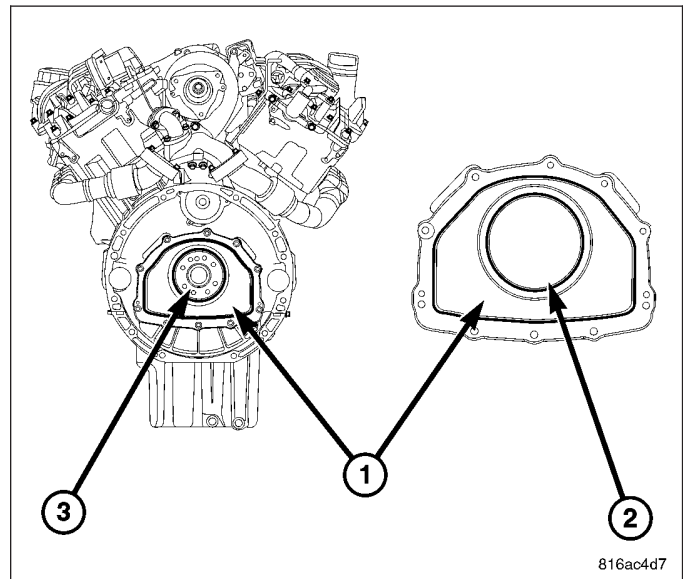
## INSTALLATION

### OIL PAN

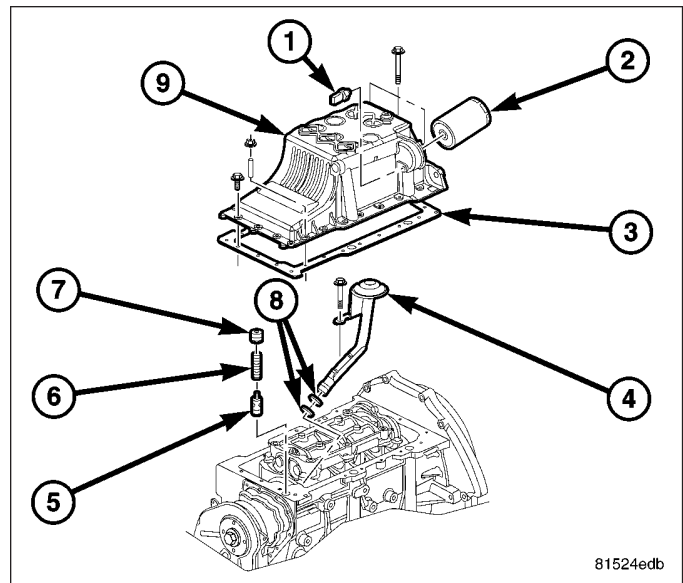
**NOTE:** Sealing surfaces must be free of a gasket material and oil residue.

**NOTE:** If installing a new oil pan, exchange the oil temperature sensor and the oil level sensor.

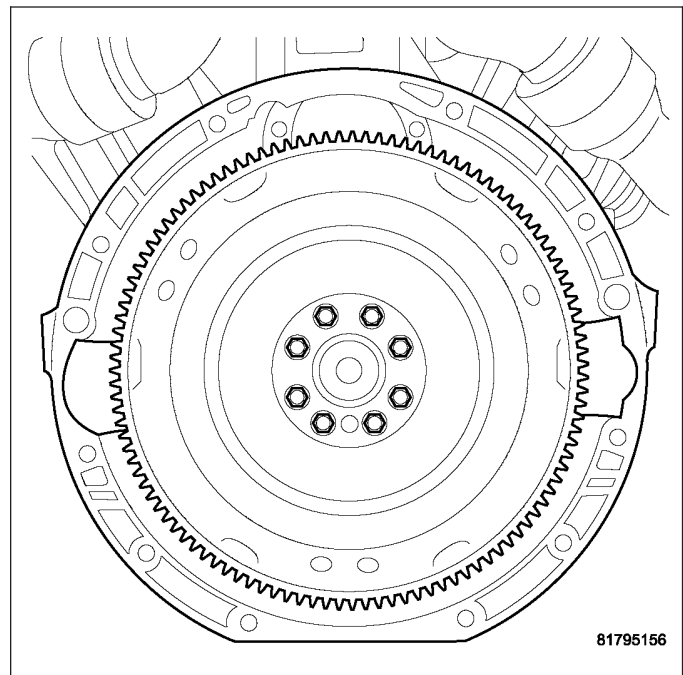
1. Install the bolts holding the rear main seal carrier (1) to the oil pan. Torque the bolts to 9 N-m (7 ft. lbs.).



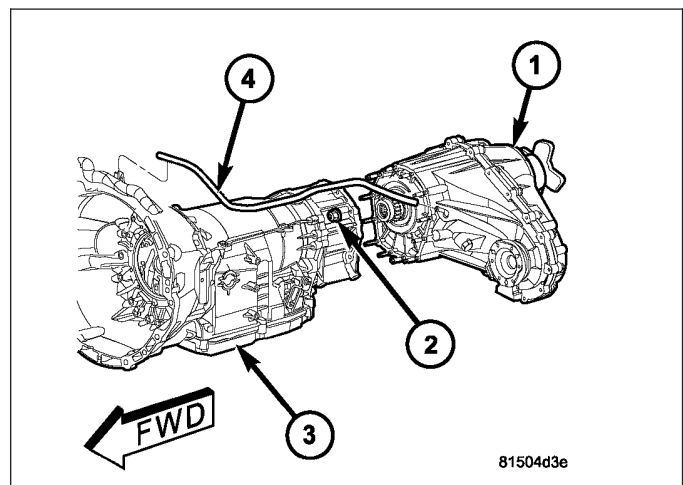
2. Push the oil pan against the transmission and tighten transmission to oil pan bolts first, including the rear main seal carrier bolts.
3. Tighten the oil pan bolts to 12 N·m (106 lbs.in.). Tighten the transmission to oil pan bolts to 20 N·m (177 in. lbs.).



4. Install the A/C compressor (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C COMPRESSOR - INSTALLATION).
5. Install the flex plate.



6. Install the transmission. (Refer to 21 - TRANSMISSION/TRANSAXLE/TRANSFER CASE - INSTALLATION)
7. Install the transfer case. (Refer to 21 - TRANSMISSION/TRANSAXLE/TRANSFER CASE - INSTALLATION)
8. Lower the vehicle and install the oil level indicator tube.
9. Fill the oil pan to the appropriate level with the correct viscosity engine oil.
10. Connect the negative battery cable.
11. Start the engine, allow to warm.
12. Turn engine off and inspect for leaks.
13. Install the skid plate.





## **VALVE-OIL PRESSURE RELIEF**

### **DESCRIPTION**

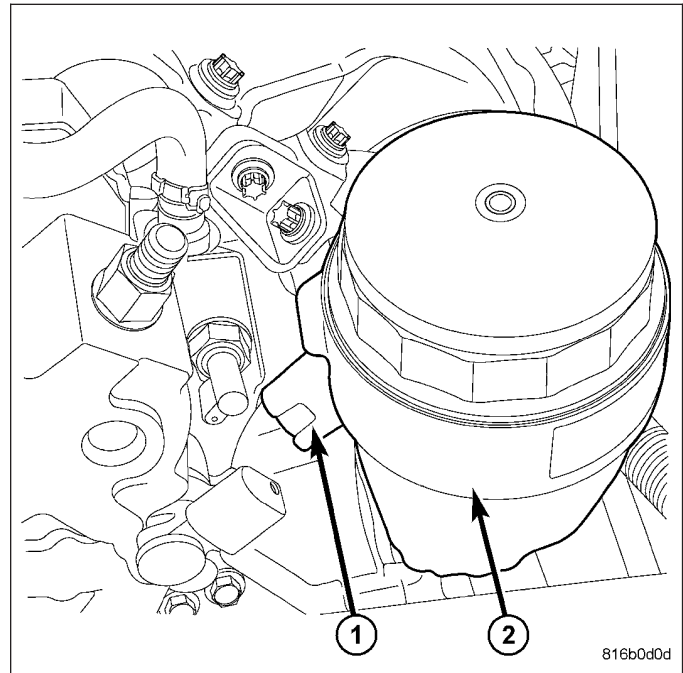
The oil pressure relief valve is integral to the oil pump and is not serviceable.

## OIL PRESSURE SENDING UNIT

### DESCRIPTION

The engine oil pressure sensor is mounted on the front of the oil filter housing. The sensor provides an output voltage to the ECM that corresponds to the engine oil pressure. Under certain operating conditions, for example low oil pressure, it may be necessary for the ECM to increase the engine idle speed to ensure adequate engine lubrication.

The engine oil pressure sensor is a three wire sensor with a threaded pressure port. The pressure port is mounted to the oil filter housing through an access hole. An aluminium seal ring seals the engine oil pressure sensor to the oil filter housing.

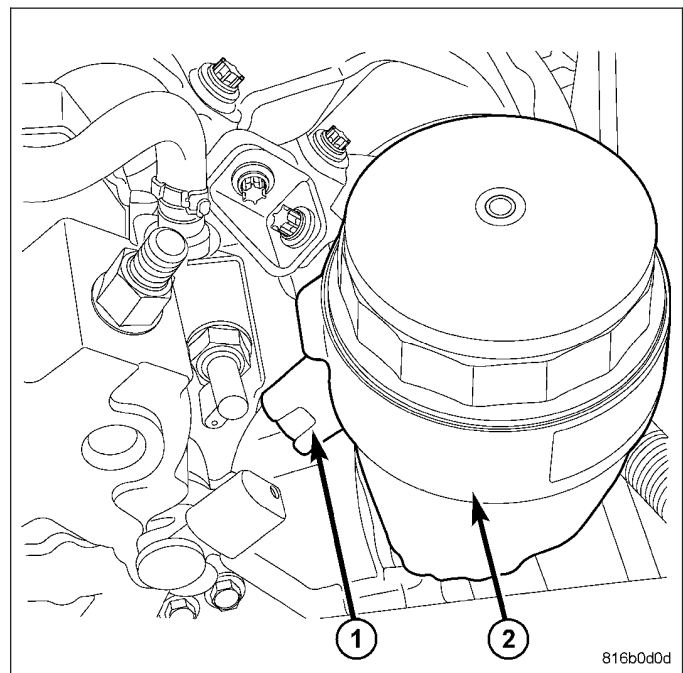


### OPERATION

The engine oil pressure sensor receives a 5- volt reference from the ECM. The sensor ground is also provided by the ECM. The sensor output voltage varies from 0.5 to 4.5 volts depending on engine oil pressure.

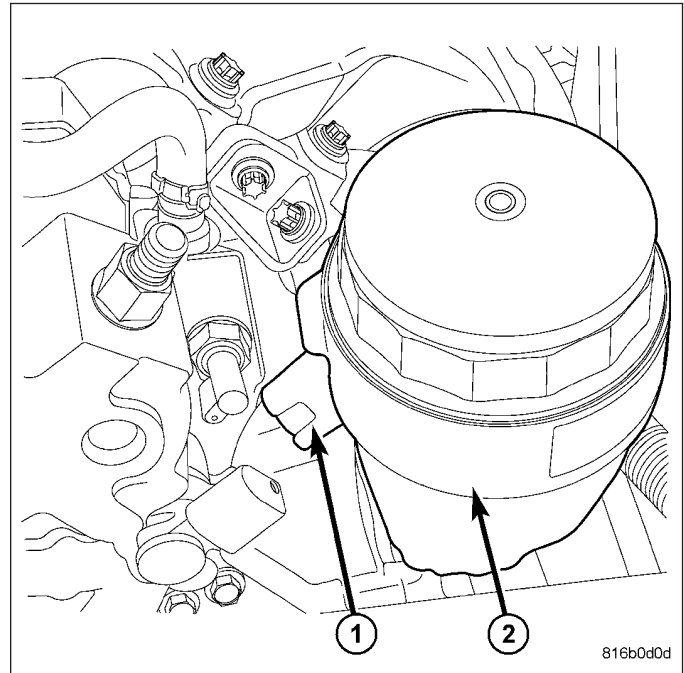
### REMOVAL

1. Open hood and disconnect negative battery cable.
2. Disconnect engine oil pressure sensor connector.
3. Remove engine oil pressure sensor from the engine.



## INSTALLATION

1. Install the engine oil pressure sensor to the engine. Torque sensor to 15 N·m (11 ft.. lbs.).
2. Connect engine oil pressure sensor electrical connector to the sensor.
3. Add engine oil and check engine oil level as needed.
4. Connect the negative battery cable.
5. Start vehicle and inspect for leaks.

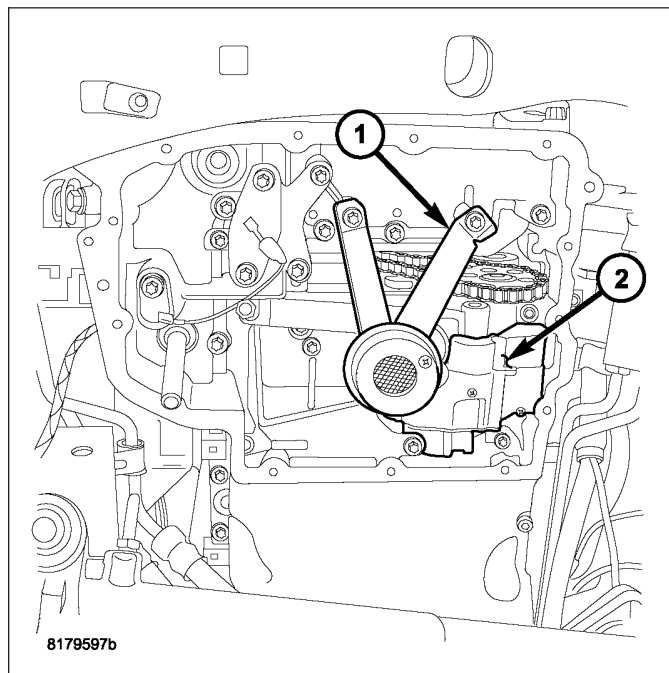


## PUMP-OIL

### REMOVAL

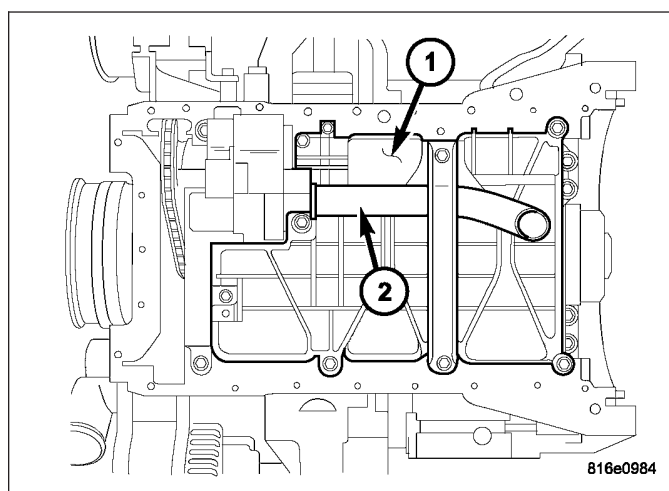
#### OIL PUMP PICKUP TUBE

1. Disconnect negative battery cable.
2. Raise vehicle on hoist.
3. Remove oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).
4. Remove oil pump pickup tube retaining bolt and pull pickup tube from engine block. Discard O-rings.

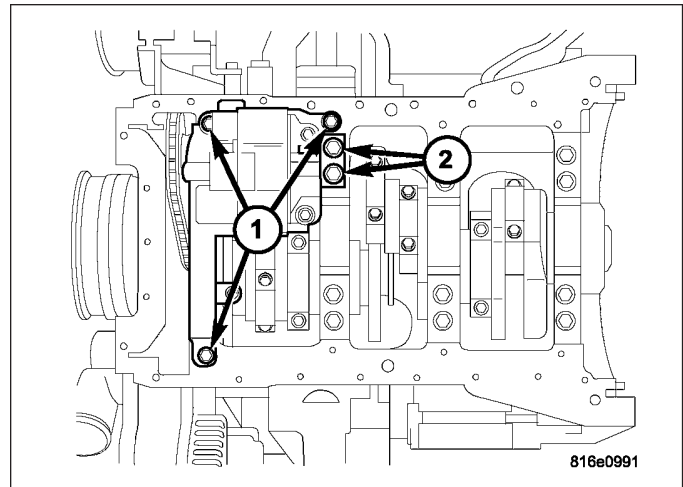


### REMOVAL

1. Remove oil pan. (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL)
2. Remove fasteners at the oil pump cover.



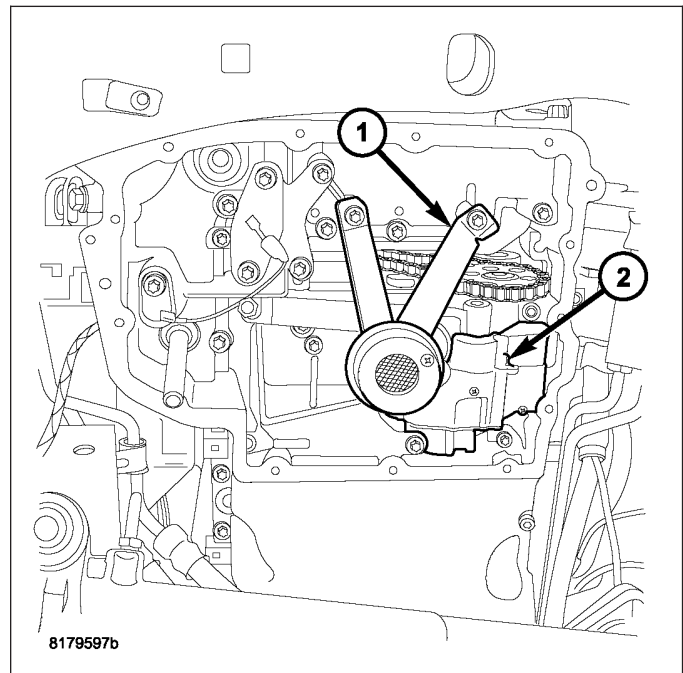
3. Remove oil pump fasteners (1).
4. Remove oil pump from the crankcase.



## INSTALLATION

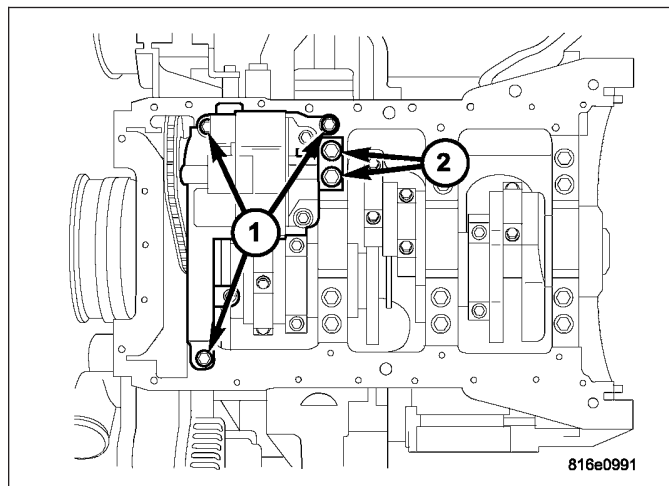
### OIL PUMP PICKUP TUBE

1. Lubricate o-rings on oil pump pickup tube with engine oil.
2. Install pickup tube in engine block and install retaining bolt. Torque bolt to 32.4 N·m. (24 ft.lbs.).
3. Install oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).
4. Refill engine oil to proper level.
5. Connect negative battery cable.

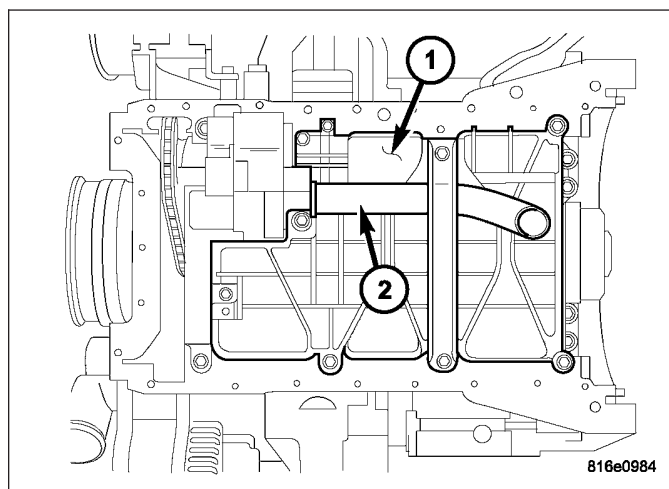


## INSTALLATION

1. Clean the strainer of the oil pump and replace sealing ring. Fill oil pump with engine oil so that oil is delivered when first starting engine.
2. Install the oil pump.



3. Install fastener for oil pump. Torque fastener to 19 N·m (14 ft. lbs.).
4. Install fastener for oil pump cover (1) with oil pipe (2) to oil pump. Torque fastener to 12 N·m (9 ft. lbs.).

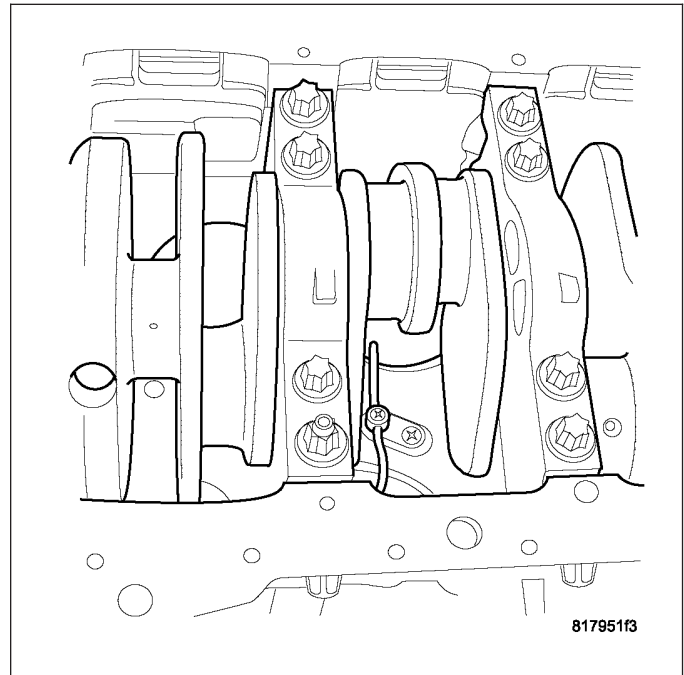


5. Install bracket to the oil pump. Torque fastener to 9 N·m (7 ft. lbs.).
6. Install oil pan. (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

## JET-OIL

### DESCRIPTION

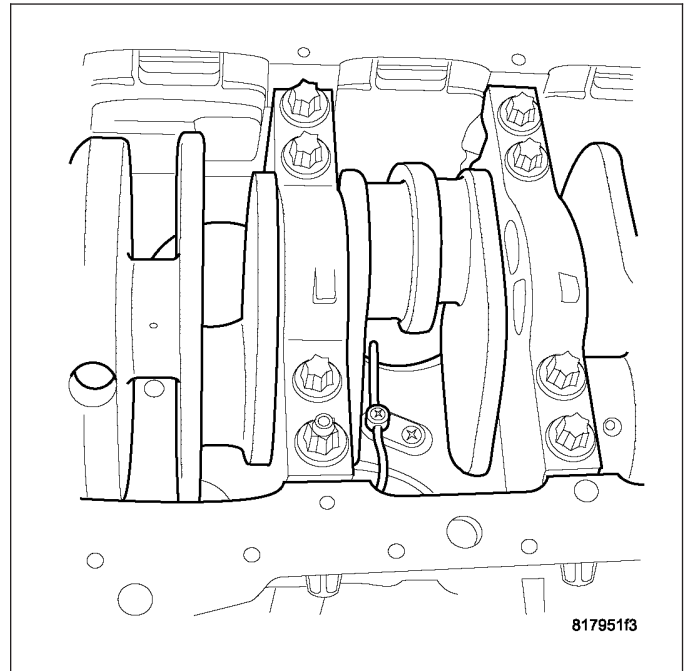
Three dual-nozzle oil jets are bolted to the cylinder block underneath the main oil gallery. The jets connect with an oil-tight fit to the main gallery through lubrication passages. Each oil jet helps cool two opposite pistons. Proper oil jet alignment is important. Each nozzle is designed to alternatively spray oil through both cooling galleries within the piston. The oil spray is aimed at one of the cooling galleries as the piston approaches TDC. As the piston approaches BDC, the oil spray is aimed at the adjacent cooling gallery.



### REMOVAL

**CAUTION:** Use caution when removing and installing oil jets. Damage to oil jet nozzle could cause severe engine damage. Care must be taken not to damage the crankshaft tone ring when removing cylinder number four oil jet.

1. Disconnect negative battery cable.
2. Raise vehicle on hoist.
3. Remove oil pan.
4. Remove oil jet retaining bolt and remove oil jet from engine block.

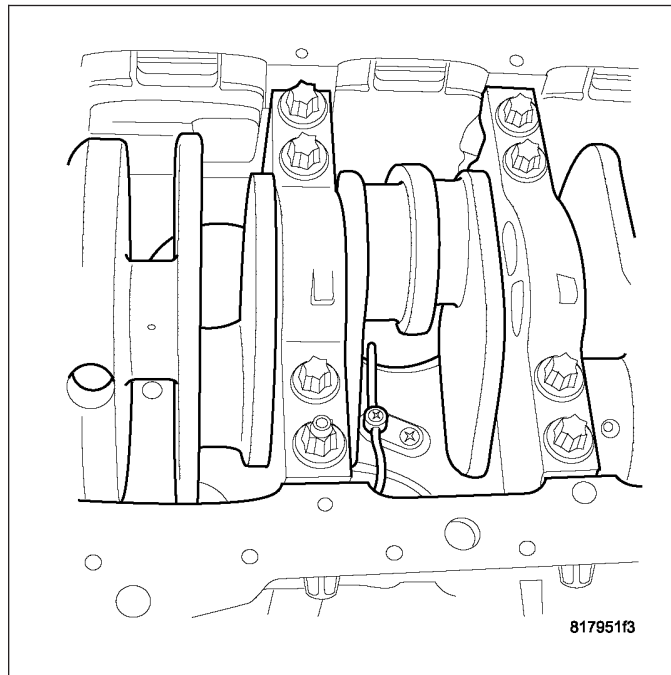




## INSTALLATION

**CAUTION:** Use caution when removing and installing oil jets. Damage to oil jet nozzle could cause severe engine damage.

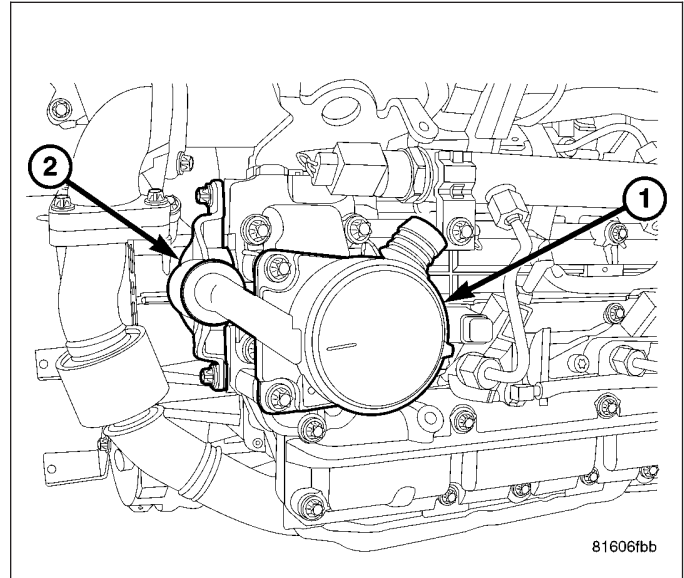
1. Lubricate o-ring on oil jet.
2. Install oil jet in engine block
3. Install oil jet retaining bolt. Torque bolt to 11N·m.(96 in.lbs.).
4. Install oil pan.
5. Fill engine oil to proper level.
6. Connect negative battery cable.



## PCV

### DESCRIPTION

Located on the rear of the right cylinder head cover is a positive crankcase ventilation (PCV) valve (1). Internal engine vapor is captured, the solid particulates are separated by a diffuser located on the right exhaust camshaft, and the vapor is reused during the combustion process.

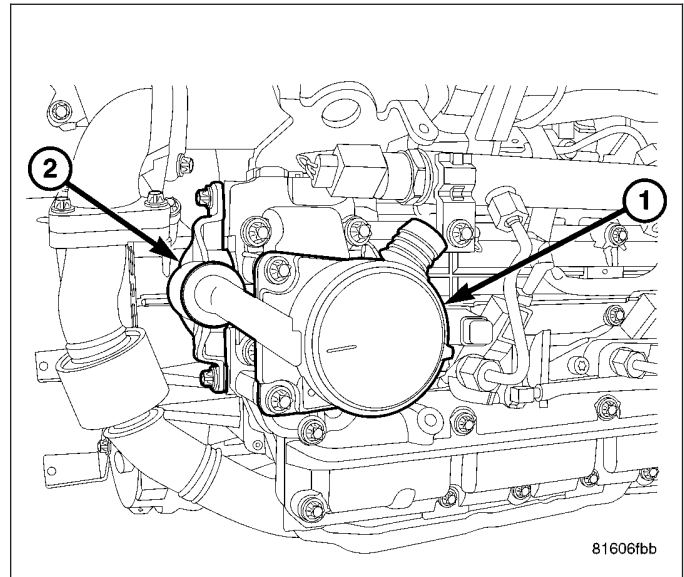


### REMOVAL

1. Remove the engine cover.

**NOTE:** Inspect the oil drain back access hole in the intake manifold/cylinder head cover to assure that it is free of obstruction.

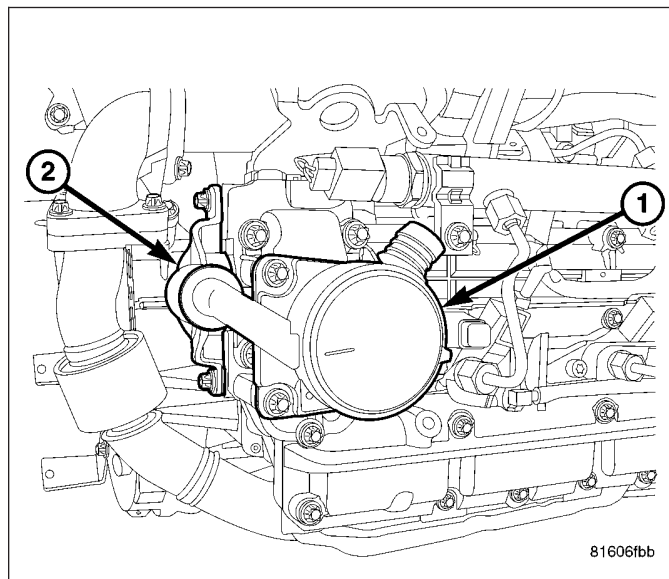
2. Remove the oil separator fasteners and oil separator.



## INSTALLATION

**NOTE:** Inspect the oil drain back access hole in the intake manifold/cylinder head cover to assure that it is free of obstruction.

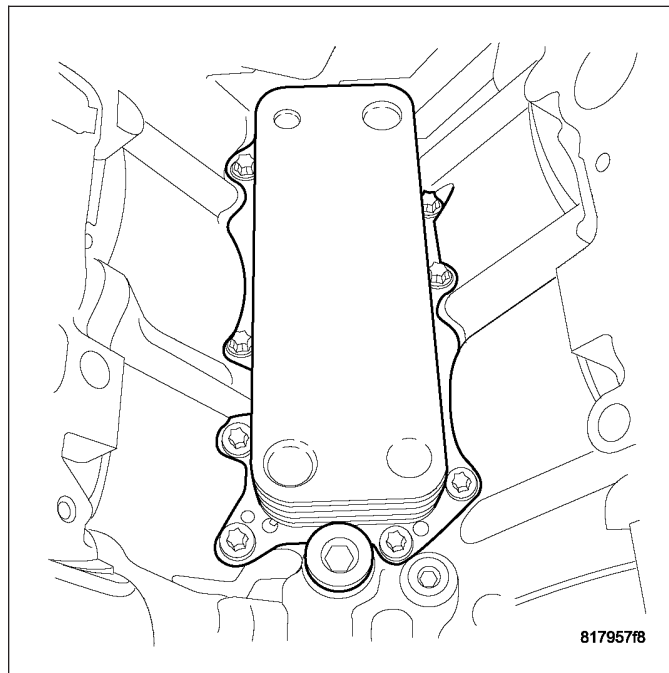
1. Lubricate the Positive Crankcase Ventilation (PCV) o-rings with clean engine oil.
2. Carefully position and push down on the PCV to seat.
3. Install the PCV retaining fasteners. Tighten fasteners to 10.8 N·m (96 lbs. in.).



## COOLER-OIL

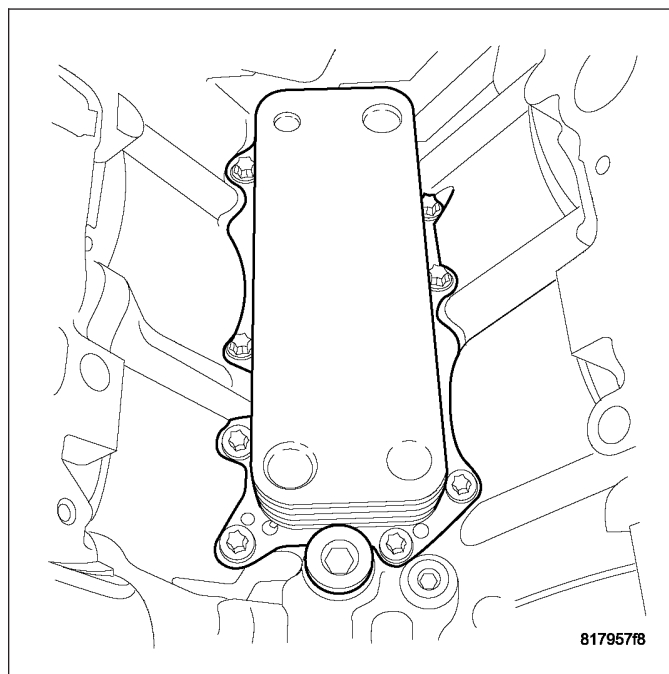
### DESCRIPTION

A plate style external oil cooler is mounted in the “V” of the engine block. Engine coolant is used to cool the oil. The gasket should be replaced anytime you are servicing the oil cooler. When replacing the engine block, inspect the oil cooler for damage or restrictions. If the oil cooler is not damaged or restricted, it can be reused. Engine coolant is used to cool the oil. A plate-style external heat exchanger is located in the valley of the cylinder block, below the EGR cooler. Two gaskets seal the oil cooler to the cylinder block. Replace the gaskets whenever the oil cooler is removed or replaced. The oil is fed to the oil cooler through the oil filter. With a maximum cooling power of 15 kW (51,200 BTU), the oil cooler ensures the maximum oil temperature does not exceed 135°C (275°F). After the oil cooler, the oil is fed to the balance shaft tunnel, which is simultaneously the main oil gallery of the cylinder block.



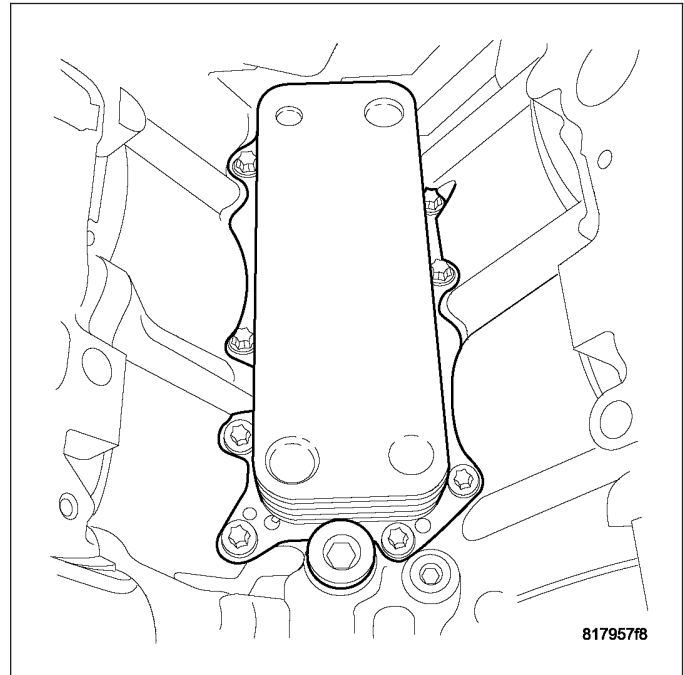
### REMOVAL

1. Disconnect the negative battery cable.
2. Drain the cooling system.
3. Remove the air cleaner assembly (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - REMOVAL).
4. Remove the coolant reservoir and hoses.
5. Remove the charge air cooler hose between turbo-charger and cooler.
6. Remove the lower radiator hose at the water pump housing assembly.
7. Remove the water pump housing assembly.
8. Remove the engine oil cooler.



## INSTALLATION

1. Clean all engine mating surfaces.
2. Position the oil cooler and gasket. Install the fasteners and tighten to 10.8 N·m (96 in. lbs.).
3. Install the water pump housing assembly with new gasket. Tighten fasteners to 24.5 N·m (18 ft. lbs.).
4. Install the oil cooler coolant hose.
5. Install the power steering reservoir.
6. Install heater hoses at housing.
7. Install lower radiator hose at housing.
8. Install the charge air hose.
9. Install coolant reservoir and hoses.
10. Install air cleaner assembly (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - INSTALLATION).
11. Fill the coolant system
12. Connect the negative battery cable
13. Start engine, run until warm, turn the engine off, and inspect for leaks.

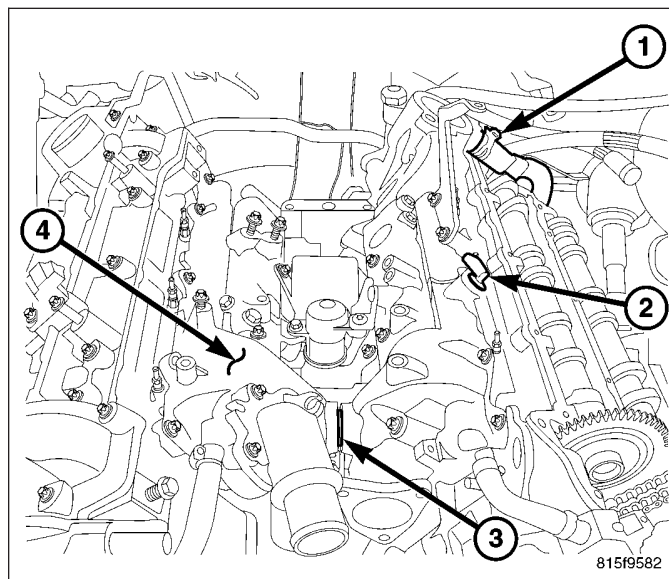


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## MANIFOLD-INTAKE

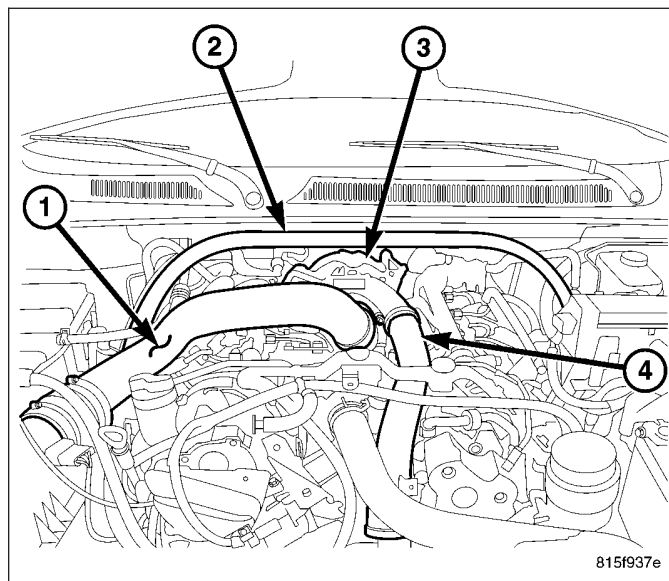
### DESCRIPTION

The aluminum intake manifold is a two piece design joined by a frontal cross coolant passage. Incorporated into the intake manifold assemblies are swirl and charge air channels. The swirl channels have blades that are electronically controlled by PWM signals from the ECM via a swirl valve actuator. In their normal resting position the swirl valves are open. Charge air and cooled EGR exhaust gasses are combined within the intake manifold. The swirl valve assembly assists in the mixing of these inlet airs within the cylinder. The swirl valves themselves are not serviceable separately, should a failure occur, the intake manifold must be replaced.



### REMOVAL

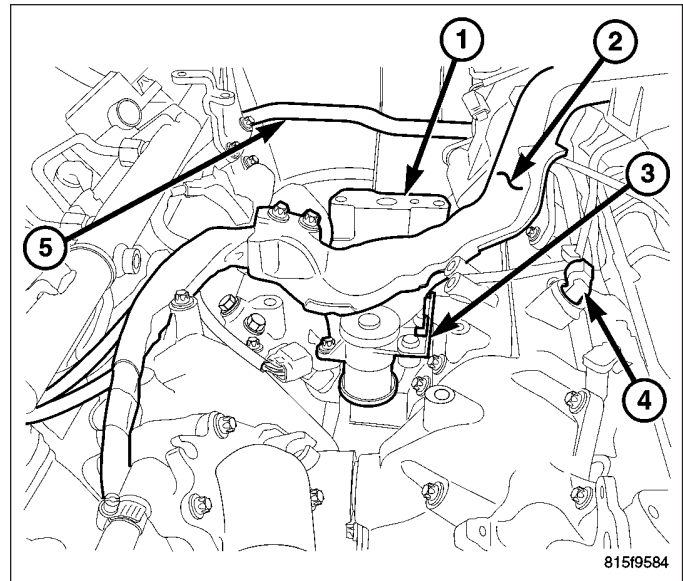
1. Disconnect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Remove the engine cover. (Refer to 9 - ENGINE - REMOVAL)
3. Drain the cooling system. (Refer to 7 - COOLING - STANDARD PROCEDURE)
4. Remove the coolant reservoir and position aside.
5. Remove the strut tower support.
6. Remove the air cleaner housing cover and air inlet tube (1).
7. Remove the charge air outlet tube (4).
8. Remove the right rear engine cover bracket and disconnect the transmission oil level indicator tube retaining bolt.



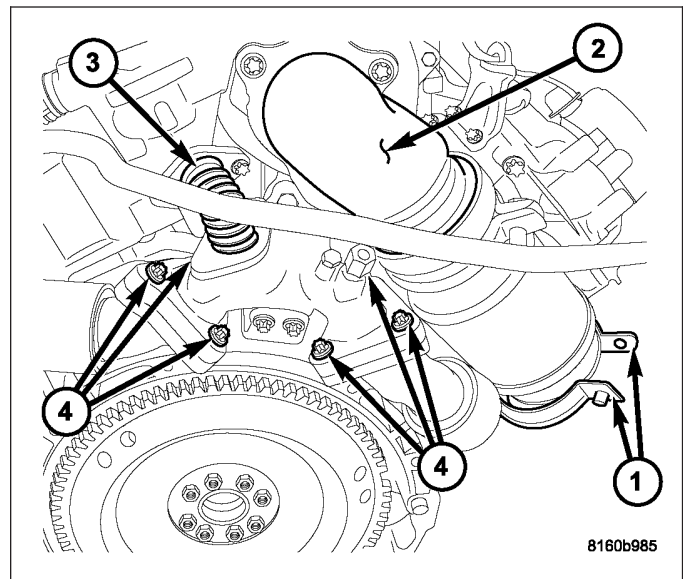
9. Remove the turbocharger. (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - REMOVAL)

**CAUTION:** Observe the position of the turbocharger oil passage housing and gasket. Failure to properly position the gasket during assembly will result in immediate turbocharger failure after assembly.

10. Remove the turbocharger oil housing adaptor (1) and gasket.

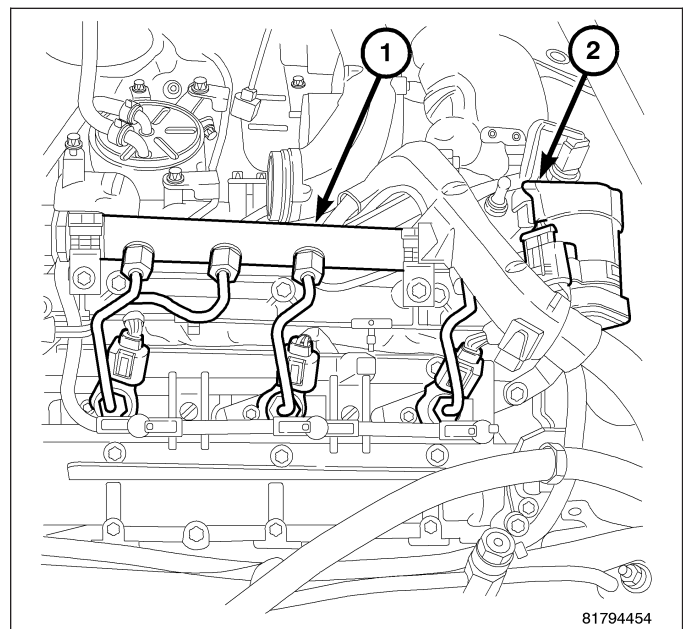


11. Remove the EGR tube (3) to the left cylinder head.
12. Disconnect the coolant hose at the EGR housing.
13. Disconnect the EGR and EGR temperature sensor wiring harness connectors.
14. Disconnect the swirl valve module wiring harness connector.



15. Remove the left fuel rail (1) and high pressure lines.
16. Remove the right fuel rail and high pressure lines.
17. Disconnect the fuel return hoses at the injectors.
18. Disconnect the return fuel hose harness and position aside.
19. Remove fuel rail transfer line.
20. Remove the fuel filter assembly.
21. Remove the fuel filter supply and return pipe harness and position aside.
22. Remove the glow plug module.
23. Remove the EGR air control valve assembly.

**CAUTION:** Do Not rest the intake manifold on the swirl valve actuator. Care must be taken when handling the swirl valve assembly.





**CAUTION:** Even after draining the cooling system, some coolant may still be in the intake manifold. Use caution when removing the intake manifold that no coolant spills into the combustion chamber. Liquids of any sort in the combustion chamber may cause a hydraulic lock of the engine and cause severe engine damage.

24. Remove the intake manifold and gasket.

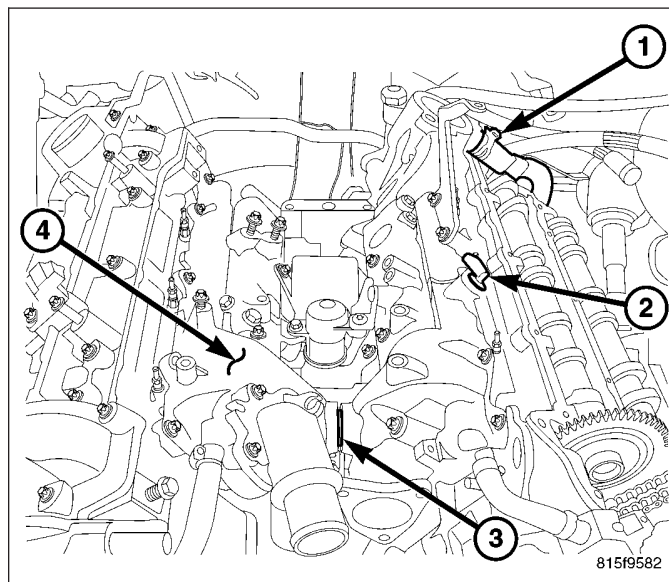
## INSTALLATION

**NOTE:** Before installation, clean cylinder heads and intake manifold surfaces.

1. Properly position the intake manifold gasket and install the intake manifold.

**CAUTION:** The right intake manifold upper thermostat housing bolts should be tightened to 8.4 N·m (74 in. lbs.).

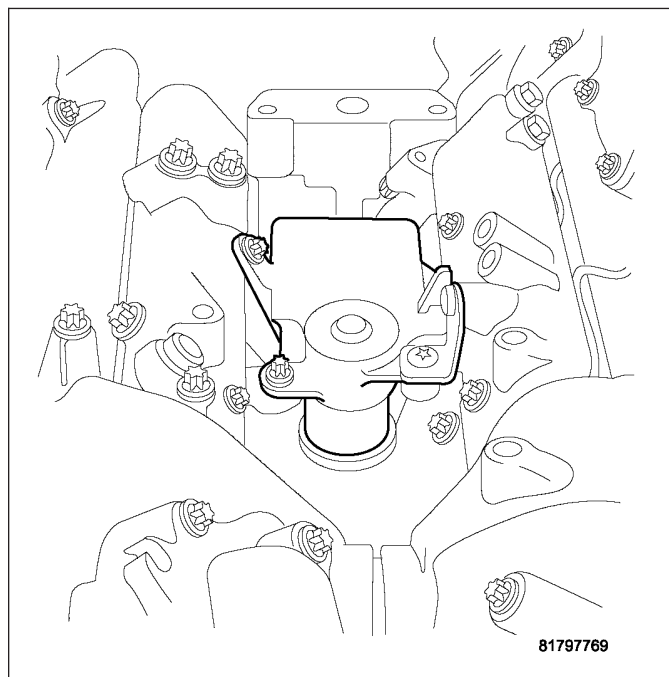
2. Tighten bolts to 16 N·m (142 in. lbs.), starting in the middle and tightening in a cross pattern outward until reaching the upper thermostat bolts on the right front manifold.
3. Tighten the upper thermostat bolts on the right cylinder head to 8.4 N·m (74 in. lbs.).



4. Install the fuel filter.
5. Position and install the fuel filter supply and return pipe harness.
6. Position and install the fuel injector return fuel hose harness.
7. Position and properly route the engine wiring harness.
8. Install the left fuel rail. Tighten bolts to 27 N·m (20 ft. lbs.).

**NOTE:** Inspect the fuel lines, especially around the barrel ends for damage. Replace as necessary.

9. Install the fuel rail transfer line along with the right fuel rail. Tighten fuel rail bolts to 27 N·m (20 ft. lbs.), and fuel pipe to 33N·m (24 ft. lbs.).
10. Install the fuel injector high pressure lines. Tighten lines to 27 N·m (20 ft. lbs.).
11. Connect the swirl valve motor electrical connector.



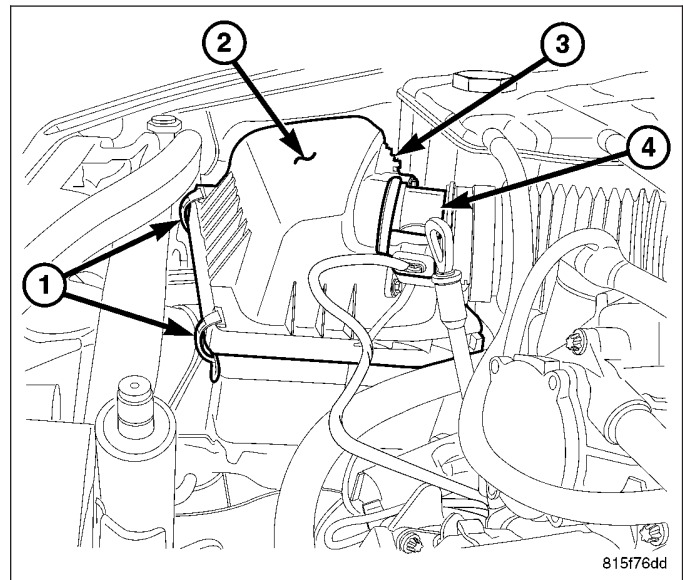
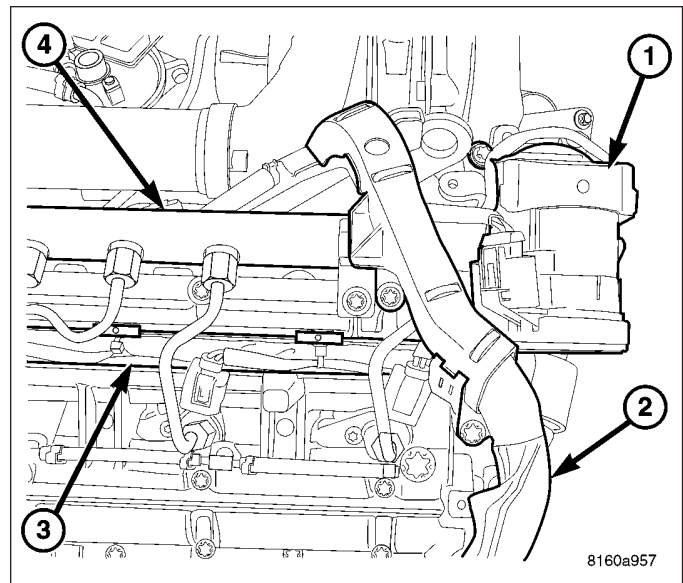
12. Connect the EGR and EGR temperature sensor wiring harness connectors.
13. Connect the coolant hose at the EGR housing.
14. Install the EGR tube to the EGR housing.

**CAUTION:** Observe the positioning of the oil housing to block gasket. This gasket must be attached to the housing and both oil passages aligned properly. Failure to do so will result in immediate turbocharger damage upon start up.

15. Install the turbocharger oil housing adaptor.
16. Install the turbocharger.
17. Install the right rear engine cover bracket and connect the transmission oil level indicator tube.
18. Install the charge air outlet tube.
19. Install the EGR air control valve assembly.
20. Install the glow plug module.
21. Install the air cleaner cover and air inlet tube.
22. Install the engine cover.
23. Install the strut tower support.
24. Fill the engine with coolant.
25. Connect the negative battery cable.

**NOTE:** Observe the fuel system warning (Refer to 14 - FUEL SYSTEM - WARNING).

26. Start the engine, allow to warm, turn the engine off and inspect for leaks.

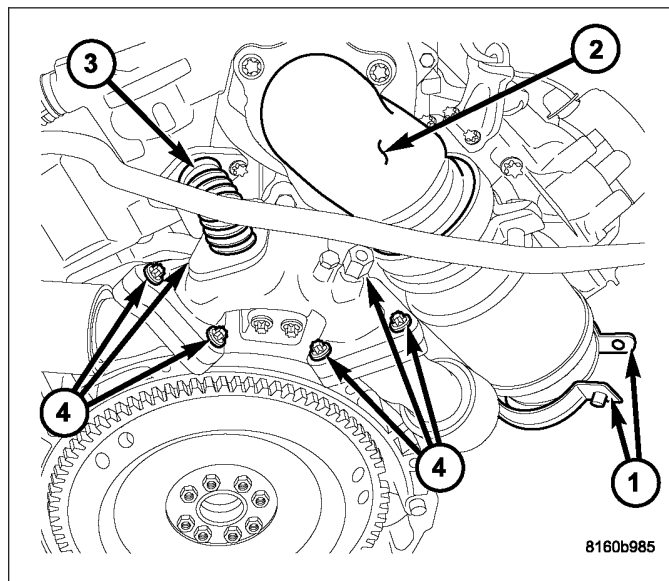


## MANIFOLD-EXHAUST

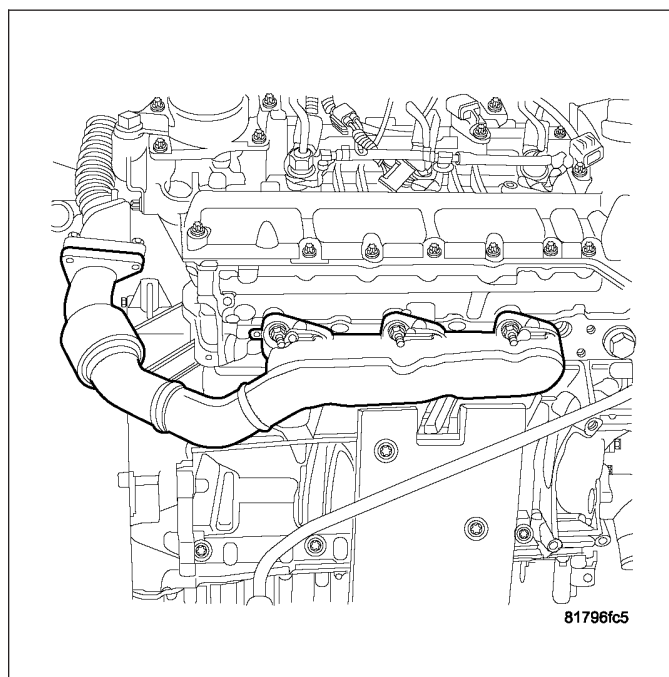
### REMOVAL

#### RIGHT

1. Disconnect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Remove the engine cover. (Refer to 9 - ENGINE - REMOVAL)
3. Remove the turbo heat shield.
4. Remove the exhaust elbow (4) at the turbo.

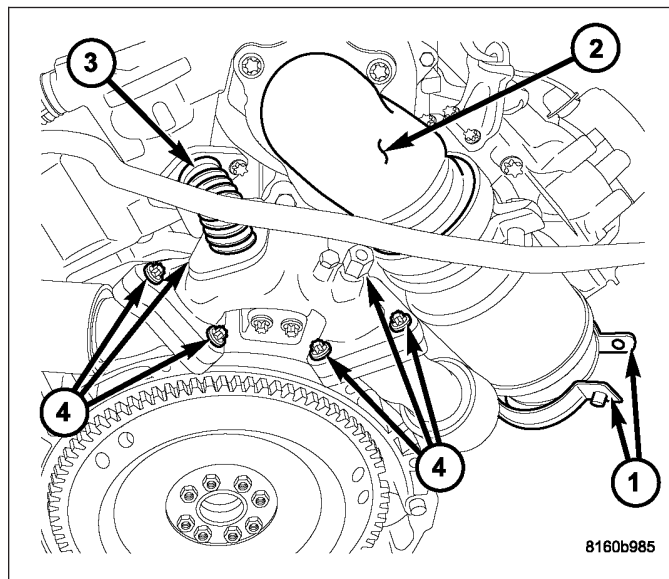


5. Remove the right exhaust manifold.

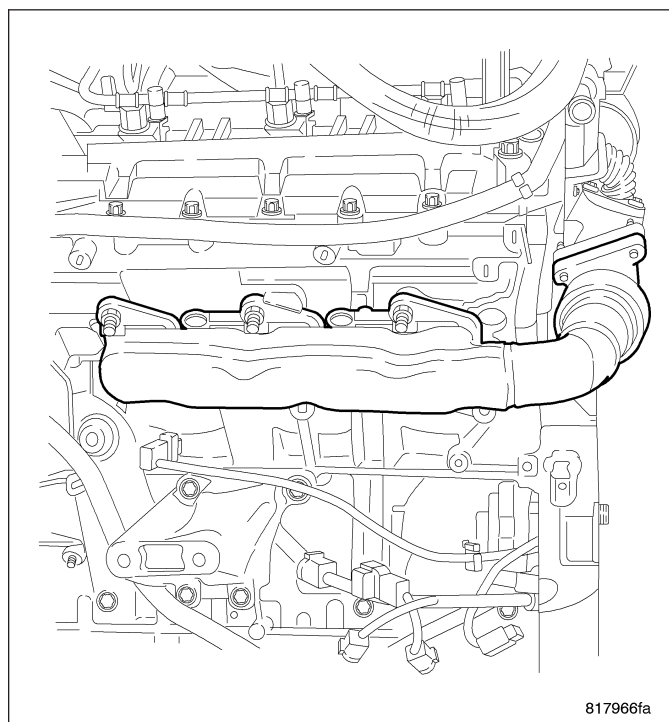


**LEFT**

1. Disconnect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Remove the engine cover. (Refer to 9 - ENGINE - REMOVAL)
3. Remove the turbo heat shield.
4. Remove the EGR tube (3).
5. Remove the exhaust elbow (4) at the turbo.



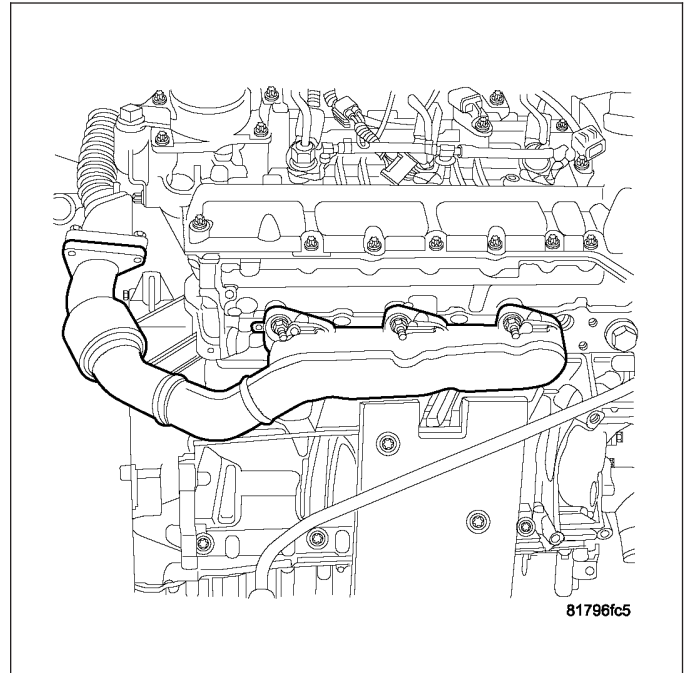
6. Remove the left exhaust manifold.



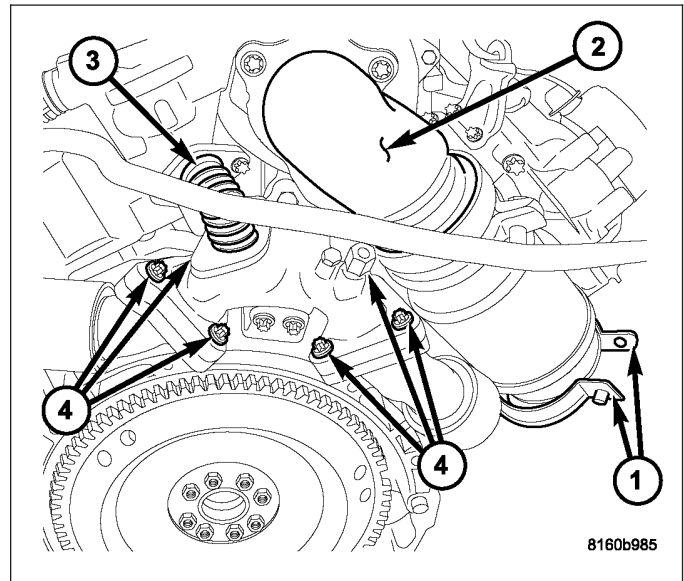
## INSTALLATION

### RIGHT

1. Discard the old gasket and clean the cylinder head and manifold sealing surfaces.
2. Install a new exhaust manifold gasket.
3. Install the right exhaust manifold to cylinder head nuts. Torque the nuts to 25 Nm ( 222 in. lbs.)

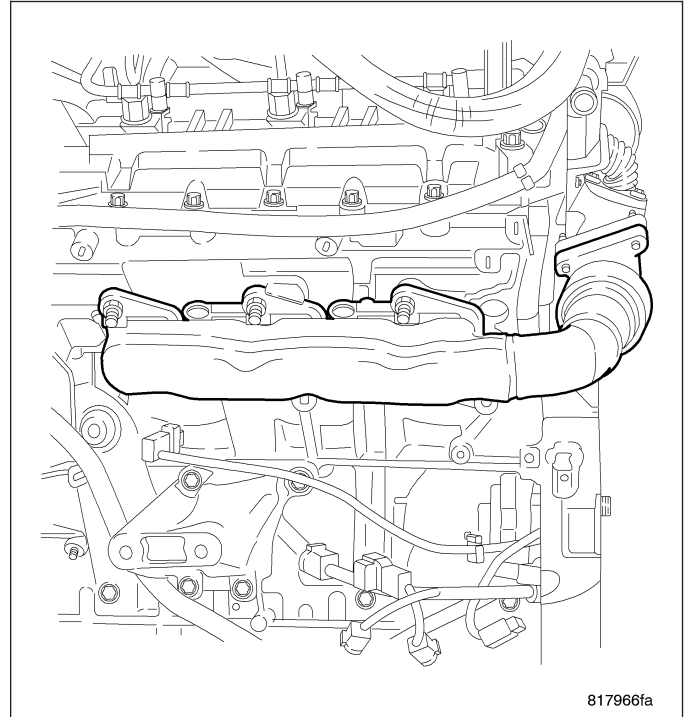


4. Install the exhaust elbow to turbocharger bolts. Torque to 20 Nm (177 in. lbs.), and then add another 90° of rotation.
5. Install the strut tower brace.
6. Install the engine cowl. (Refer to 23 - BODY/EXTERIOR/COWL GRILLE - INSTALLATION)
7. Install the engine cover. (Refer to 9 - ENGINE - INSTALLATION)
8. Connect the negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - INSTALLATION)

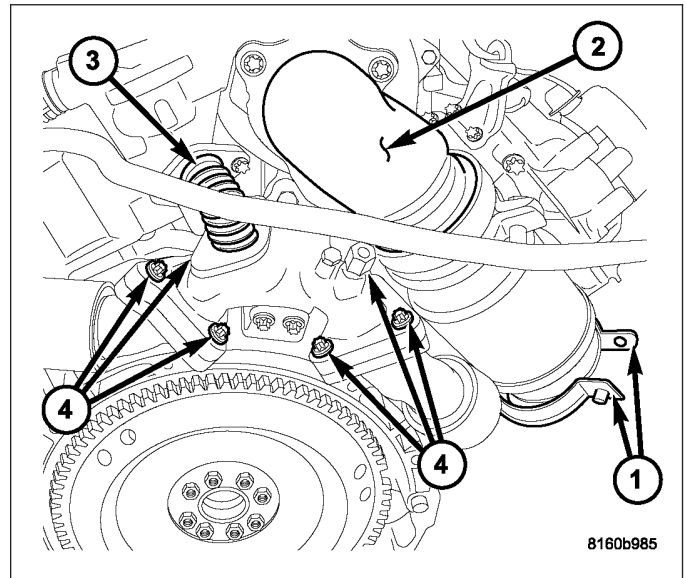


**LEFT**

1. Discard the old gasket and clean the cylinder head and manifold sealing surfaces.
2. Install a new exhaust manifold gasket.
3. Install the left exhaust manifold to cylinder head nuts. Torque the nuts to 25 Nm ( 222 in. lbs.)



4. Install the exhaust elbow to turbocharger bolts. Torque to 20 Nm (177 in. lbs.), and then add another 90° of rotation.
5. Install the turbocharger heat shield. Torque to 25 Nm ( 222 in. lbs.).
6. Install the engine cover. (Refer to 9 - ENGINE - INSTALLATION)
7. Connect the negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - INSTALLATION)



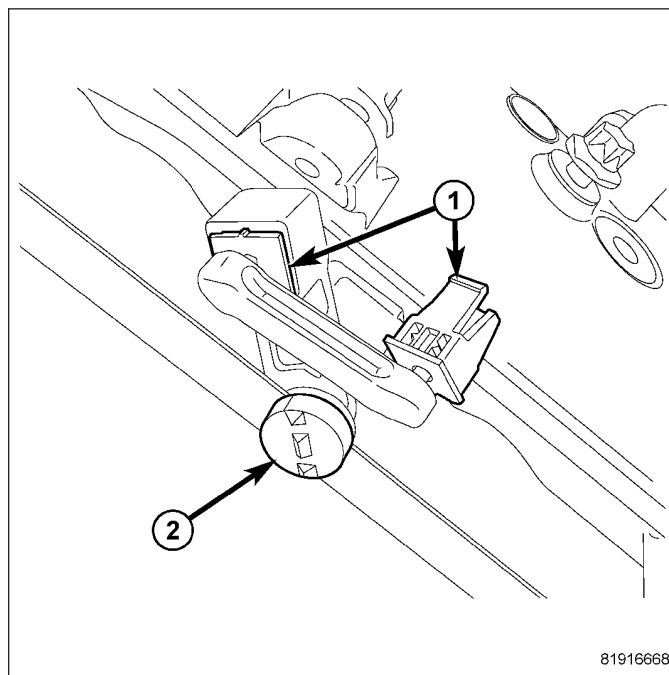
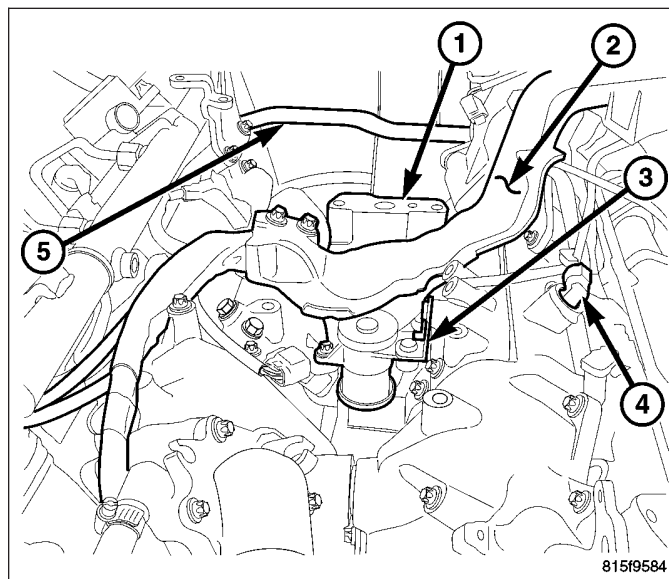
## ACTUATOR-SWIRL VALVE

### DESCRIPTION

The intake manifolds feature swirl intake ports to reduce particulates at low engine speeds. Each cylinder incorporates one swirl port and one charge port. The swirl ports can be closed by the swirl valves. The valves are connected together via a linkage which is operated by the swirl valve actuator.

The swirl valves are normally open by spring tension. The spring is integral with the swirl valve actuator. In the lower engine speed and load range, the swirl valves are closed by the swirl valve actuator. The entire air mass flows through the charge ports only, which results in greater swirling. The increased swirling produces uniform combustion for better engine performance and reduction of particulates. As rotational speed and load increases, the swirl valves open, so that optimal swirling and the required air mass are provided for the current operating conditions.

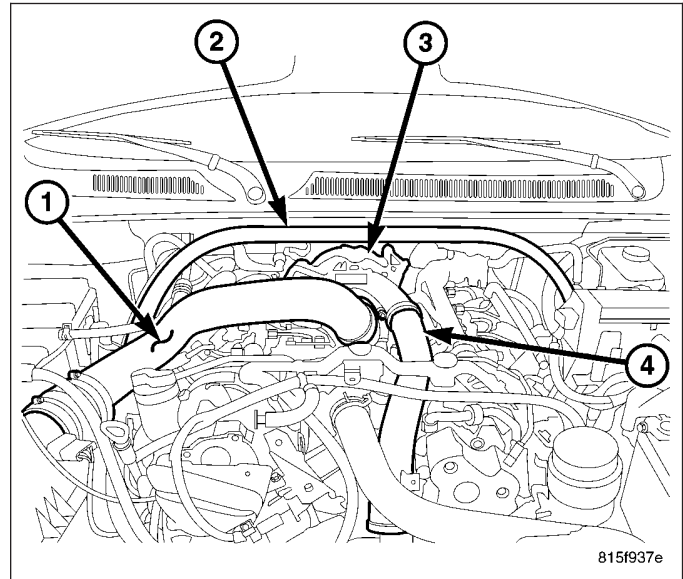
The linkage between the swirl valve actuator and the intake manifold has two different style clips. The square clip (1) is a two piece design, and the round clip (2) is a one piece design.





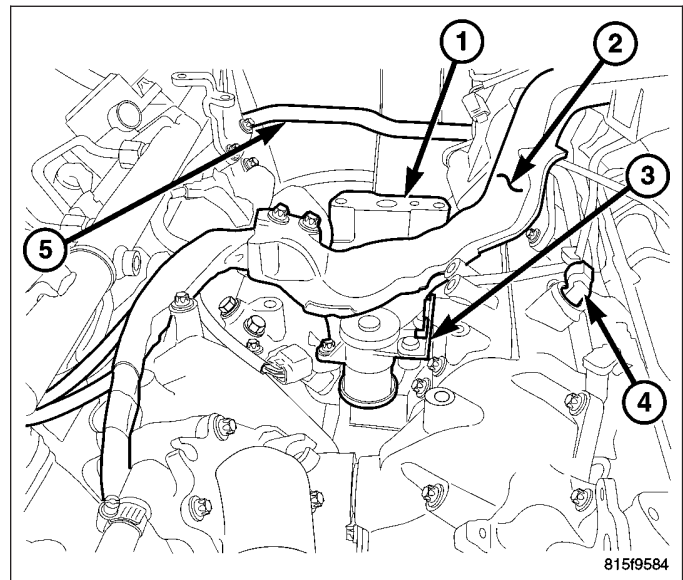
## REMOVAL

1. Disconnect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Remove the engine cover. (Refer to 9 - ENGINE - REMOVAL)
3. Drain the coolant. (Refer to 7 - COOLING - STANDARD PROCEDURE)
4. Remove the cowl. (Refer to 23 - BODY/EXTERIOR/COWL GRILLE - REMOVAL)
5. Remove the strut tower support (2).
6. Remove the intake air housing and tube. (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - REMOVAL)
7. Remove the charge air cooler tube (4).
8. Remove the resonator.
9. Remove the EGR tube.



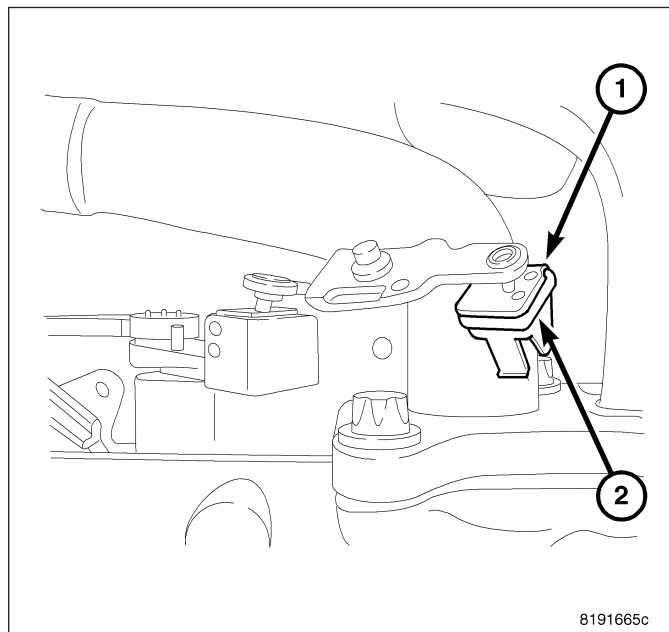
**CAUTION:** Observe the position of the turbocharger oil passage housing and gasket. Failure to properly position the gasket during assembly will result in immediate turbocharger failure after assembly.

10. Remove the turbocharger (3). (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - REMOVAL)
11. Disconnect the engine harness and position aside.
12. Disconnect the swirl valve actuator connector.
13. Remove the swirl valve actuator (3) clips.
14. Remove the swirl valve actuator.

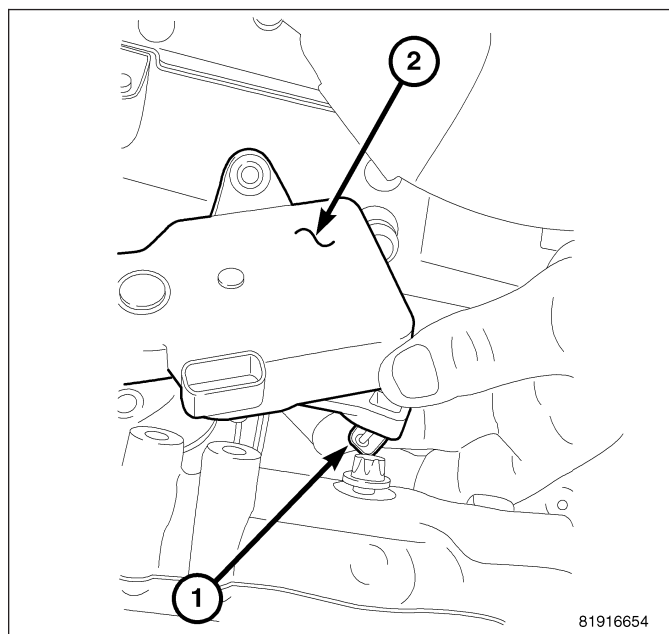


## INSTALLATION

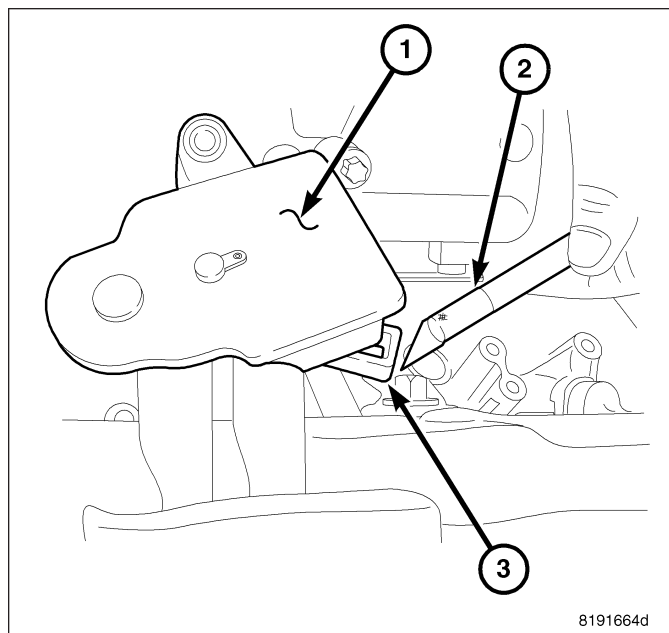
1. Assemble the two halves of the square clip around the actuator arm, and place a 5/16" O-ring (2) around the base of the clip (1) to hold it together.



2. Position the clip into the actuator arm and push the clip partially into the arm.



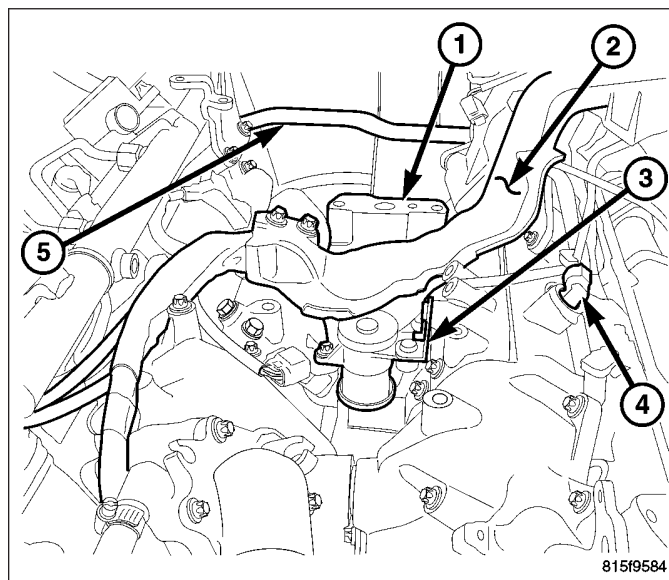
3. Cut the O-ring and press the clip the rest of the way into the actuator arm. Make sure the clip clicks into place.



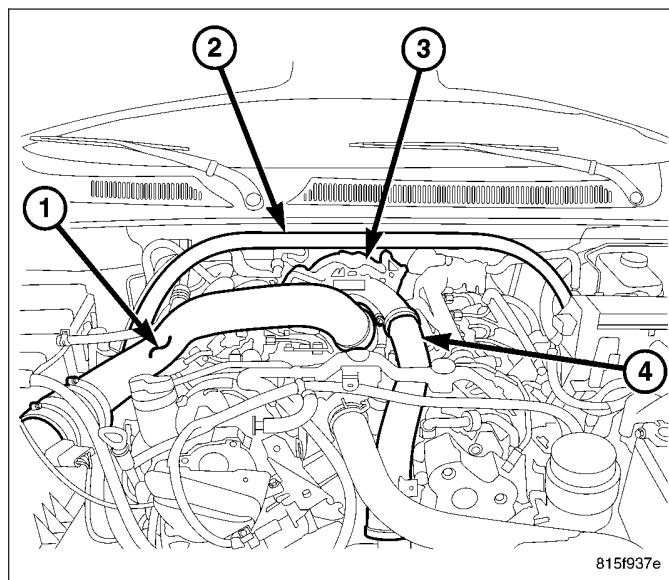
4. Install the swirl valve actuator. Tighten the bolts to 8 nm (44 lbs. in.).
5. Connect the swirl valve connector.
6. Position and connect the engine harness.

**CAUTION:** Observe the position of the turbo-charger oil passage housing and gasket. Failure to properly position the gasket during assembly will result in immediate turbocharger failure after assembly.

7. Install the turbocharger. (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - INSTALLATION)



8. Install the EGR tube.
9. Install the resonator.
10. Install the charge air cooler tube (4).
11. Install the air cleaner housing and air tube. (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - INSTALLATION)
12. Install the strut tower support (2).
13. Install the cowl trim panel. (Refer to 23 - BODY/ EXTERIOR/COWL GRILLE - INSTALLATION)
14. Fill the cooling system. (Refer to 7 - COOLING - STANDARD PROCEDURE)
15. Install the engine cover. (Refer to 9 - ENGINE - INSTALLATION)
16. Connect the battery. (Refer to 8 - ELECTRICAL/ BATTERY SYSTEM/CABLES - INSTALLATION)

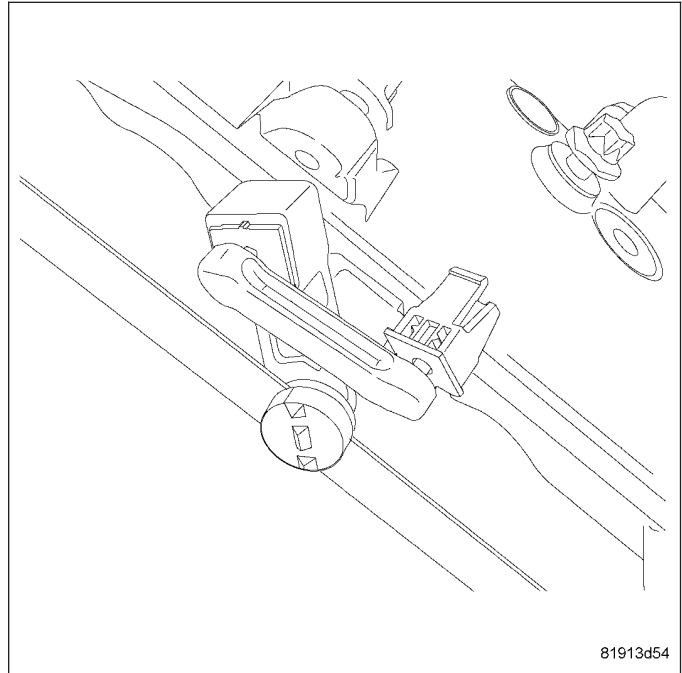


## LINKAGE-SWIRL VALVE

### DESCRIPTION

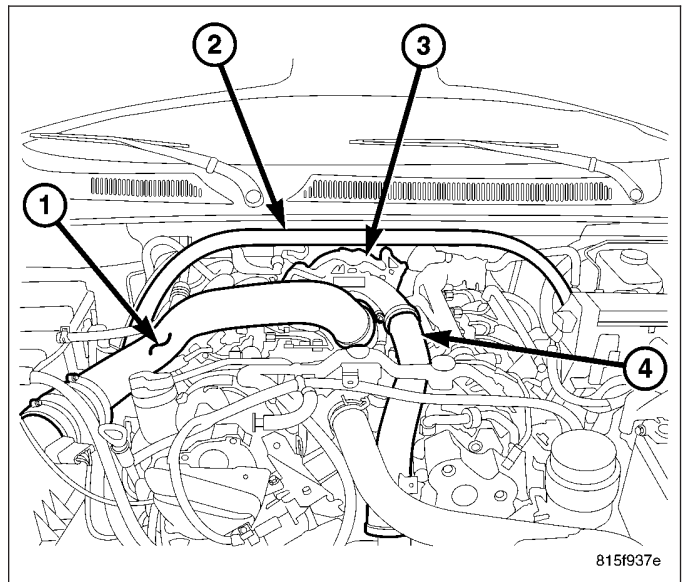
The swirl valve linkage links the swirl valves in the intake manifold to the swirl valve actuator.

The swirl valve linkage has two different style clips. The square clip (1) is a two piece design, and the round clip (2) is a one piece design.

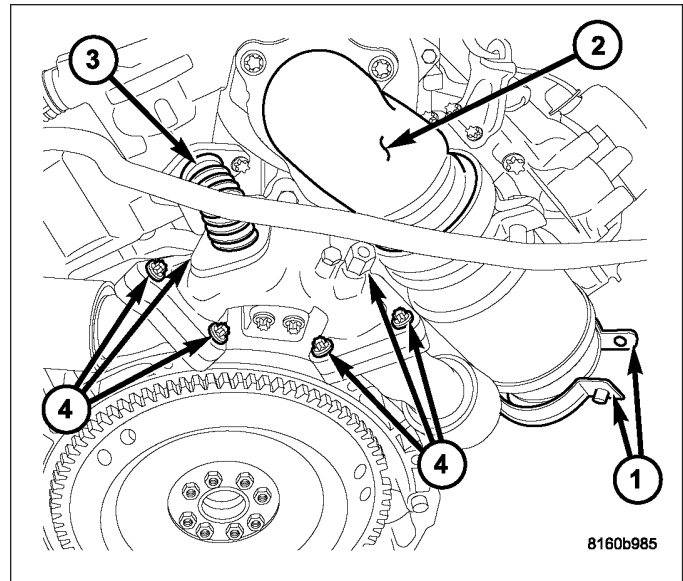


### REMOVAL

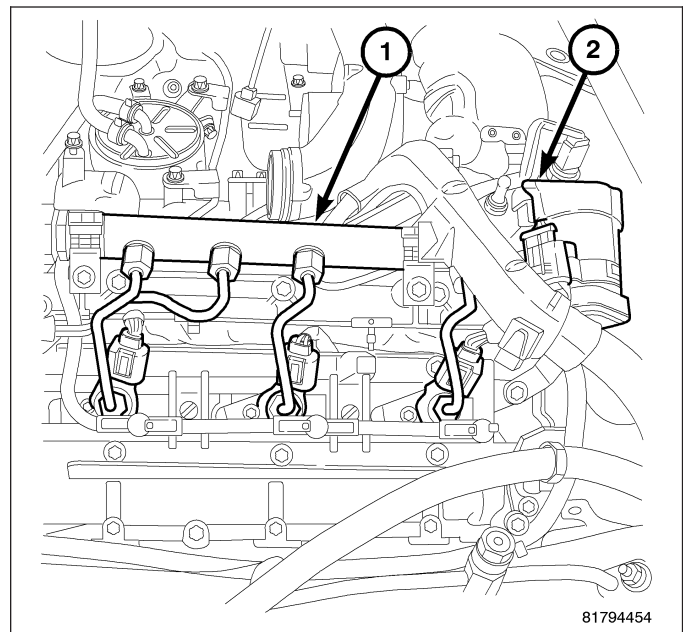
1. Disconnect the negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Remove the engine cover. (Refer to 9 - ENGINE - REMOVAL)
3. Remove the air cleaner assembly. (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - REMOVAL)
4. Remove the air charge resonator.
5. Remove the air charge outlet tube (4).
6. Remove the vapor control valve.
7. Drain the coolant. (Refer to 7 - COOLING - STANDARD PROCEDURE)
8. Remove the engine compartment lower silencer.



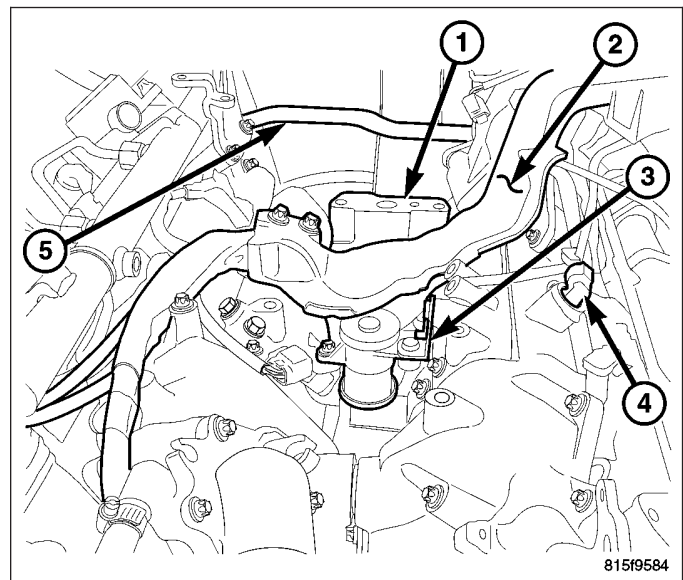
9. Remove the turbocharger. (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - REMOVAL)
10. Remove the EGR tube.
11. Remove the oil housing adapter.
12. Remove the rear engine lift bracket at the intake manifold.
13. Remove the front engine lift bracket at the cylinder heads.



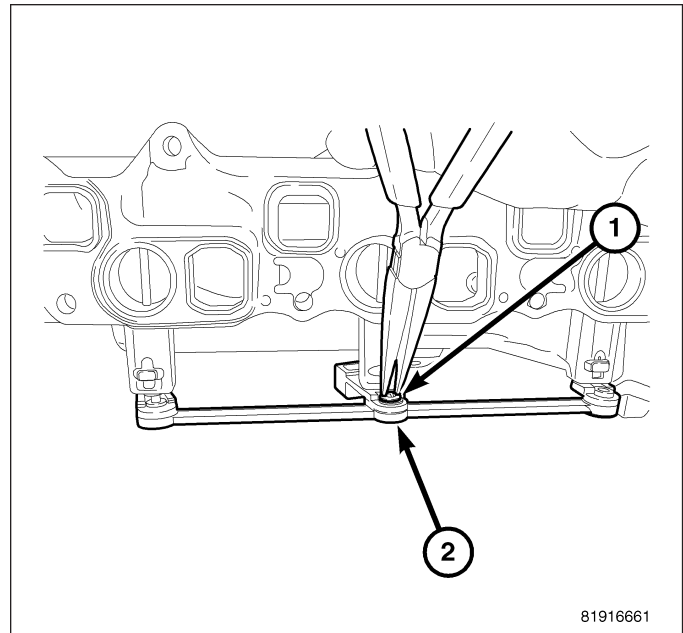
14. Remove the left fuel rail and lines. (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL)
15. Remove the right fuel rail and lines. (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/FUEL INJECTOR - REMOVAL)



16. Disconnect the engine harness (2) and position aside.
17. Remove the fuel filter assembly.
18. Remove the swirl port actuator (3).
19. Remove the heater hose at the EGR valve.
20. Remove the EGR control assembly.
21. Remove the coolant hose at the thermostat housing.
22. Remove the glow plug module.
23. Remove the charge air resonator.
24. Remove the intake manifold.

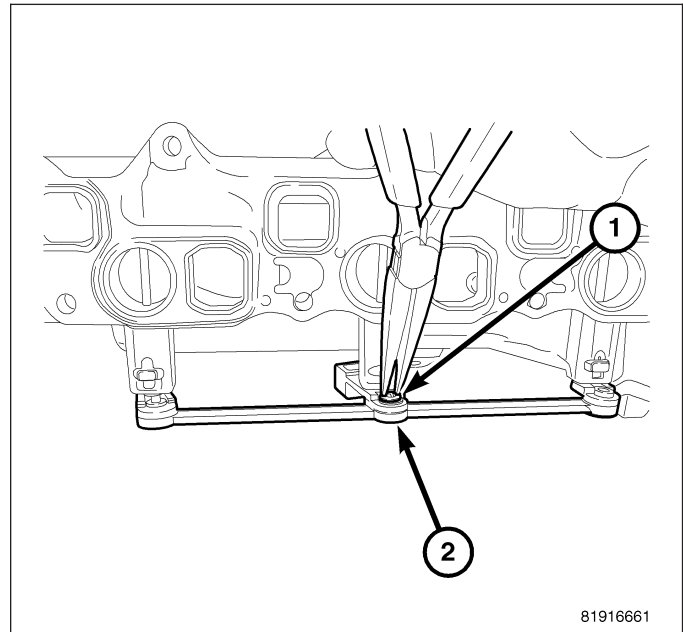


25. Loosen the EGR cooler bolts to gain access to the swirl valve linkage clips.
26. Remove the swirl valve linkage clips.



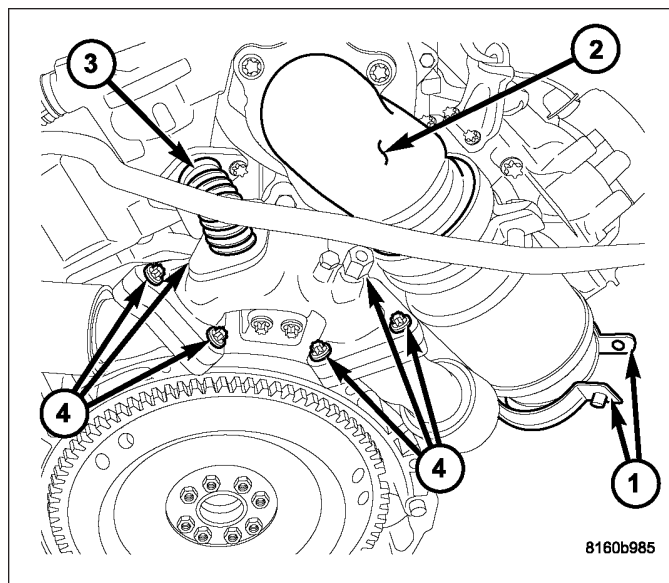
## INSTALLATION

1. Install the round clips (2) into the swirl valve linkage.
2. Clean the intake manifold sealing surfaces.

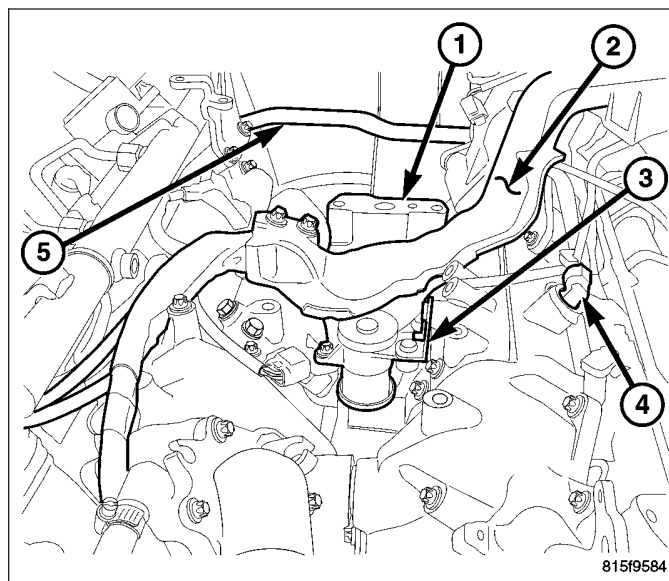




3. Install the EGR cooler.
4. Position the intake manifold and torque to 20.34 N.m (180 lbs. in.)
5. Install the throttle control assembly.
6. Install the glow plug module.
7. Install the coolant hose at the thermostat housing.
8. Install the EGR control assembly.
9. Install the EGR control assembly chamber retaining bolts.
10. Install the EGR control assembly retaining bracket.



11. Install the swirl valve actuator. (Refer to 9 - ENGINE/MANIFOLDS/ACTUATOR-SWIRL VALVE - INSTALLATION)
12. Install the fuel filter assembly. (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL FILTER / WATER SEPARATOR - INSTALLATION)
13. Install the fuel lines. (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL LINES - INSTALLATION)
14. Position and connect the engine harness.
15. Install the front lifting bracket.
16. Install rear lifting bracket.
17. Install the EGR tube.
18. Install the turbocharger. (Refer to 11 - EXHAUST SYSTEM/TURBOCHARGER SYSTEM/TURBOCHARGER - INSTALLATION)
19. Install the engine compartment lower silencer.
20. Fill the cooling system. (Refer to 7 - COOLING - STANDARD PROCEDURE)
21. Install the vapor control valve.
22. Install the charge air outlet tube (4).
23. Install the charge air resonator.
24. Install the air cleaner assembly. (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - INSTALLATION)
25. Install the engine cover. (Refer to 9 - ENGINE - INSTALLATION)
26. Connect the batteries. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - INSTALLATION)

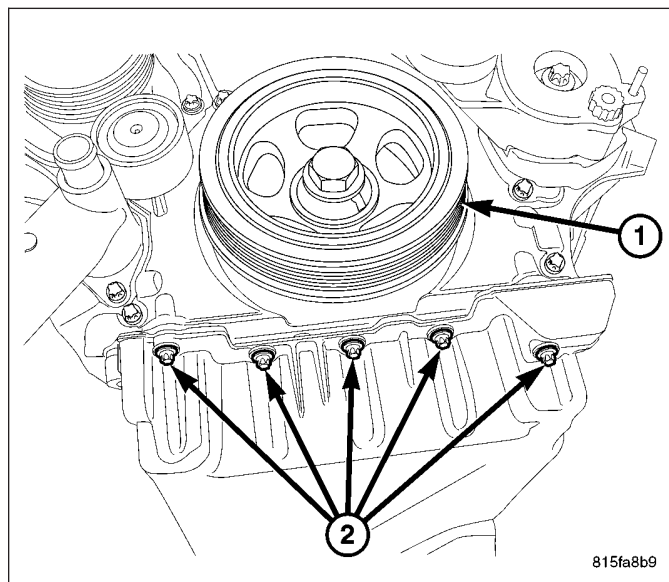
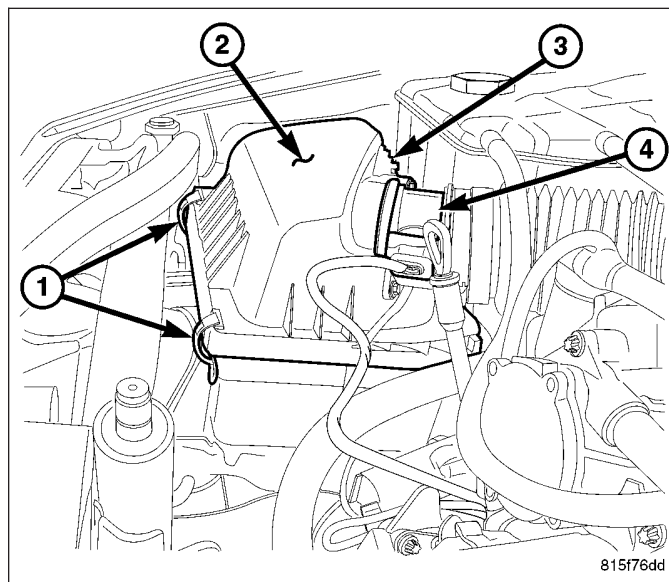




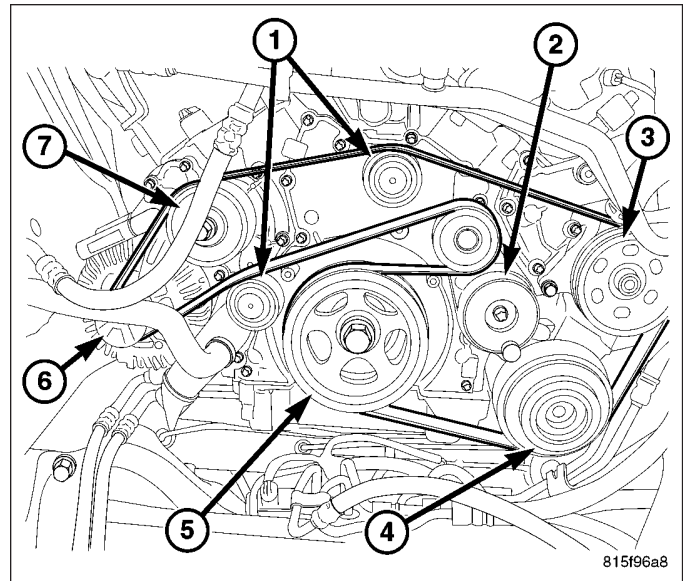
## COVER-TIMING CHAIN

### REMOVAL

1. Disconnect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Remove the engine cover.
3. Remove the front engine cover bracket.
4. Raise and support the vehicle.
5. Drain the power steering into a suitable and appropriately marked container.
6. Remove the power steering hose between the pump and cooling fan.
7. Remove the power steering hose between the cooling fan and suspension.
8. Remove the lower cooling fan module retaining bolts.
9. Disconnect the cooling fan wiring harness connector.
10. Remove the power steering line between the retainer and cooling fan module.
11. Remove the front splash shield.
12. Remove the front oil pan to timing cover bolts.
13. Lower the vehicle.
14. Remove the hoses at the power steering reservoir.
15. Remove the cooling fan module upper bolts and remove the fan assembly.
16. Remove the charge air outlet tube.



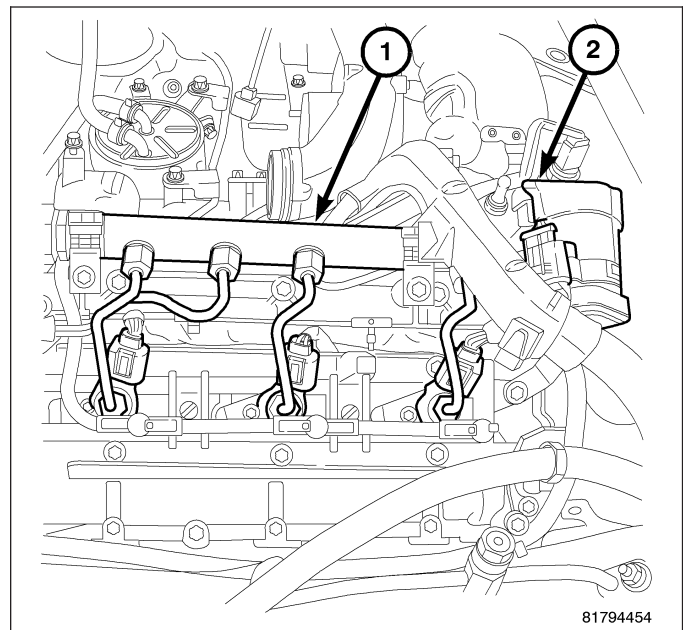
17. Remove the accessory drive belt.
18. Disconnect the charge air inlet hose at the EGR air control valve.
19. Remove the glow plug module.



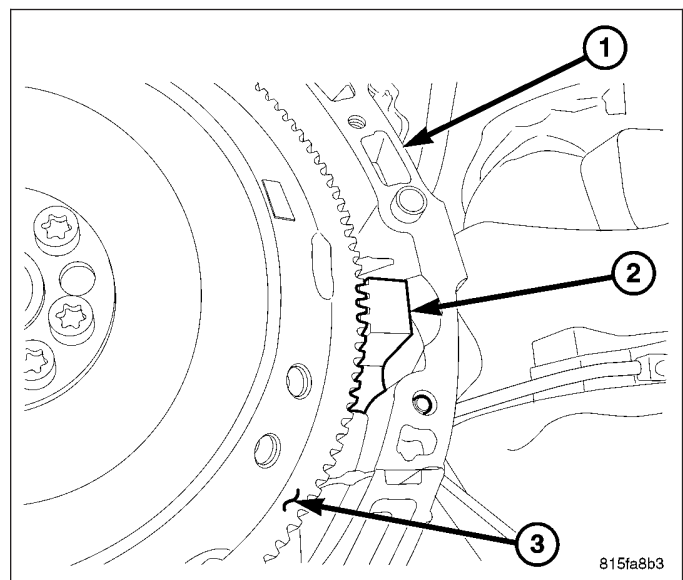
20. Remove the EGR air control valve.

**NOTE: Idler pulley fasteners are L. H. thread.**

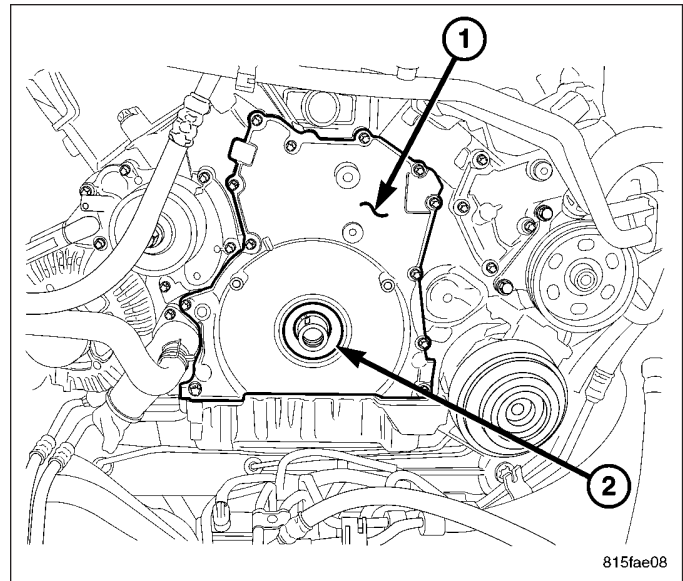
21. Remove both accessory drive belt idler pulleys.
22. Remove the accessory drive belt tensioner.
23. Rotate the engine to TDC by the crankshaft bolt.



24. Raise and support the vehicle.
25. Remove the starter blank.
26. Install special tool 9102 crankshaft lock.
27. Lower the vehicle.



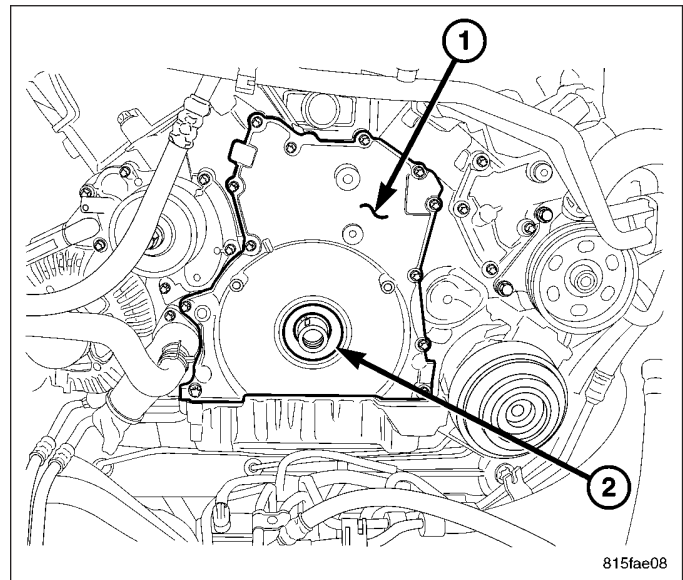
28. Remove the vibration damper and pulley.
29. Remove the front timing cover seal.
30. Remove the front timing cover bolts and cover.



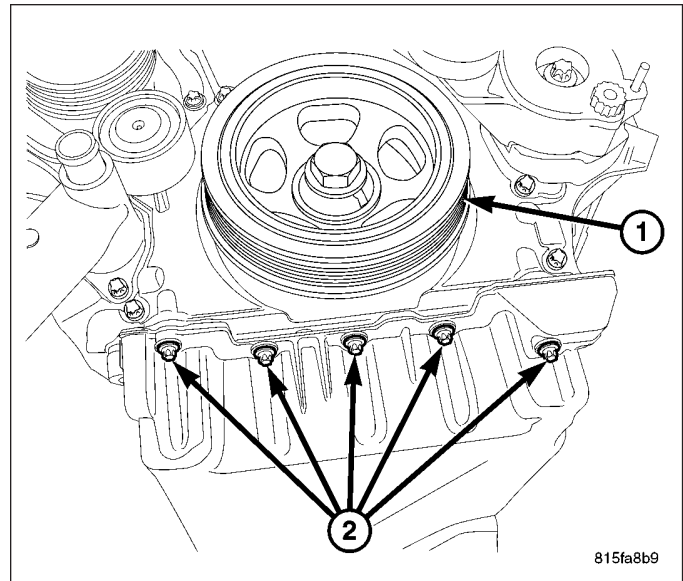
## INSTALLATION

**NOTE:** Component mating surfaces must be clean and free of all oil residue.

1. Install the front crankshaft seal in the timing cover (1).
2. Install the timing cover (1). Tighten bolts to 9 N·m (7 ft. lbs.).
3. Raise and support the vehicle.



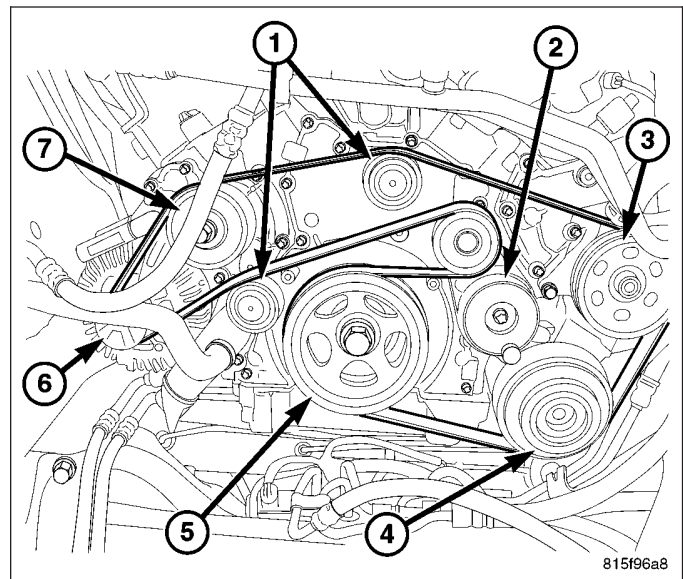
4. Install the front oil pan bolts. Tighten bolts to 14 N·m (10 ft. lbs.).
5. Lower the vehicle.



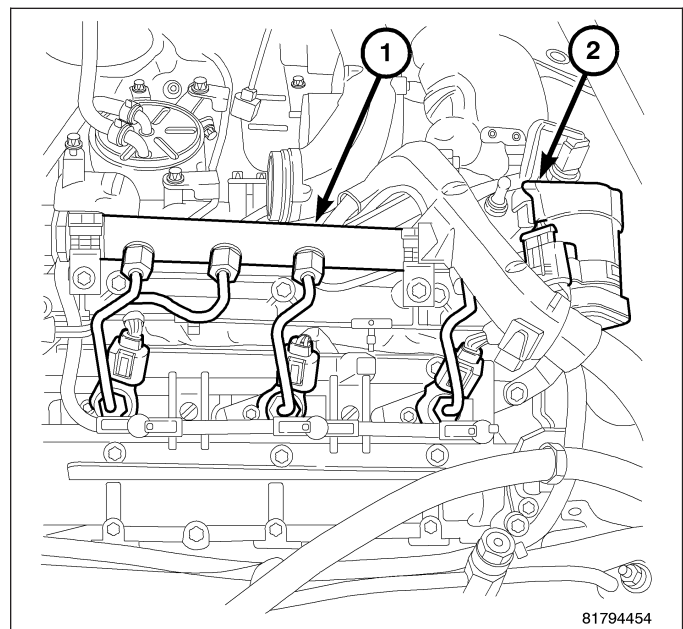
6. Install the vibration damper and pulley. Tighten bolt to 200 N·m (148 ft. lbs.), and then an additional 90°
7. Install the accessory drive belt tensioner. Tighten bolt to 58 N·m (43 ft. lbs.).

**NOTE: Idler pulley bolts are L. H. thread.**

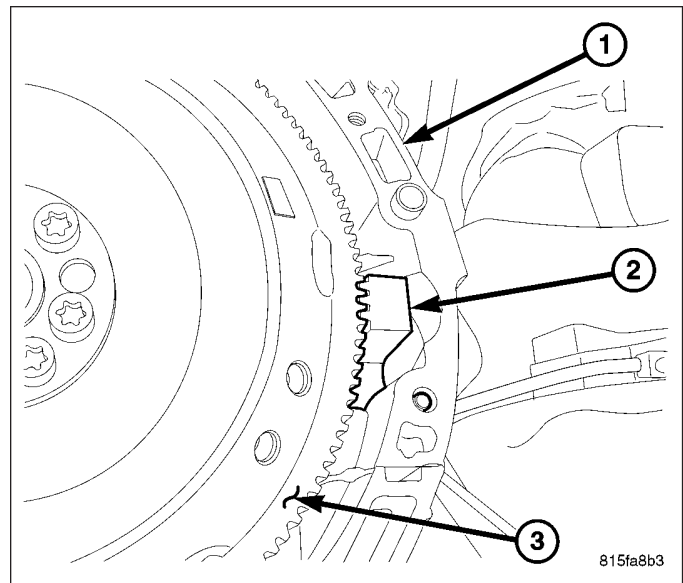
8. Install the idler pulleys. Tighten bolts to 58 N·m (43 ft. lbs.).
9. Install the accessory drive belt.



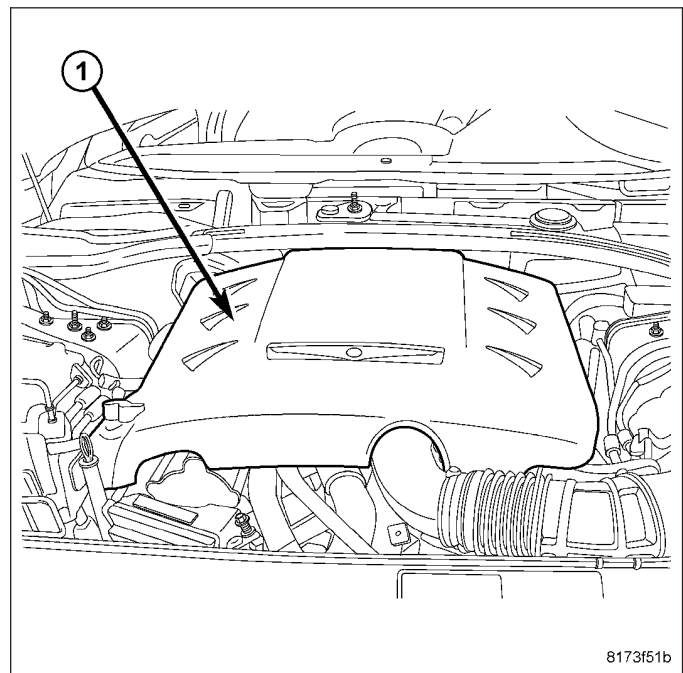
10. Install the EGR air control valve assembly.
11. Install the glow plug module.
12. Install the charge air outlet tube.
13. Install the cooling fan module. Tighten upper bolts to 14 N·m (10 ft. lbs.).
14. Raise and support the vehicle.



15. Remove special tool 9102 crankshaft lock.
16. Install the starter blank.
17. Install the lower cooling fan module bolts. Tighten lower bolts to 14 N·m (10 ft. lbs.).
18. Install the power steering line between the retainer and cooling fan module.
19. Connect the cooling fan wiring harness connector.
20. Install the power steering hose between the cooling fan and suspension.
21. Install the power steering hose between the pump and cooling fan.
22. Install the front skid plate.
23. Lower the vehicle.
24. Install the hoses at the power steering reservoir.
25. Fill the power steering reservoir.



26. Install the front engine cover bracket.
27. Install the engine cover.
28. Connect the negative battery cable.
29. Purge the air from the power steering system before starting by raising the vehicle and rotating the steering wheel back and forth 20 times.
30. Start the engine and follow the bleed procedure with the scan tool.
31. Turn engine off and inspect for leaks.



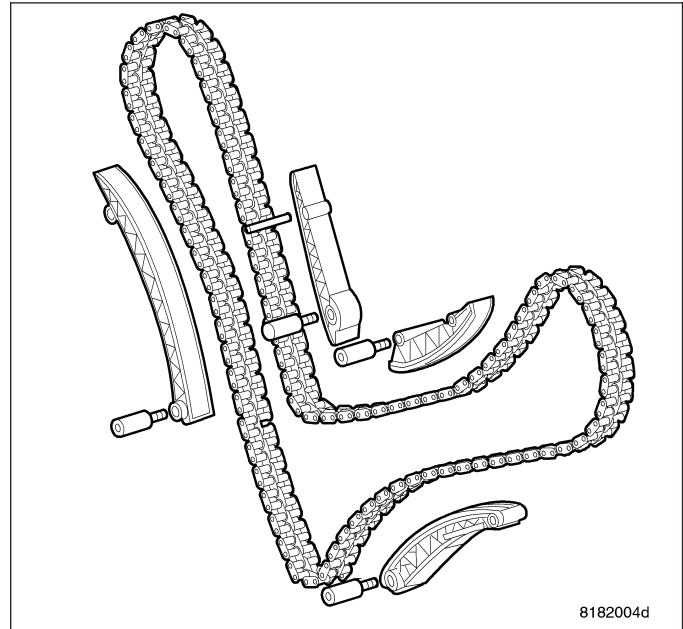
## SPROCKETS-TIMING CHAIN AND

### REMOVAL

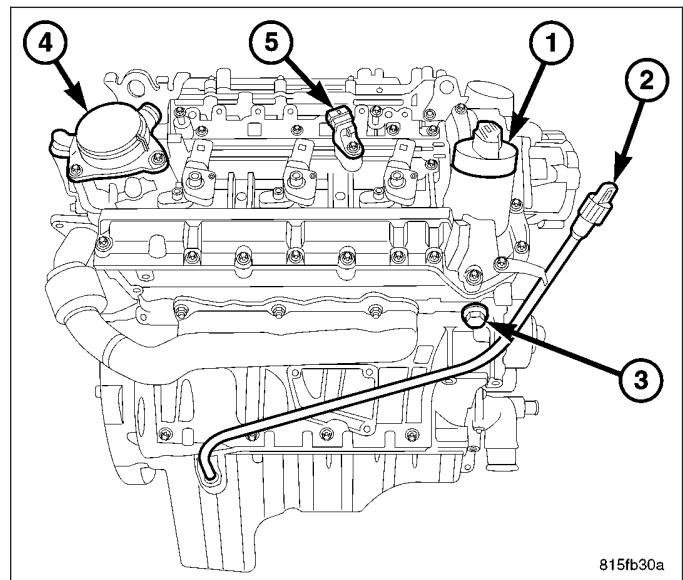
#### TIMING CHAIN GUIDE - UPPER

**NOTE:** When servicing the timing chain guides, both the upper and the lower guide should be replaced in pairs.

1. Disconnect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Remove the left cylinder head cover. (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL)
3. Remove the right cylinder head cover. (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL)
4. Remove the timing chain cover. (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL)

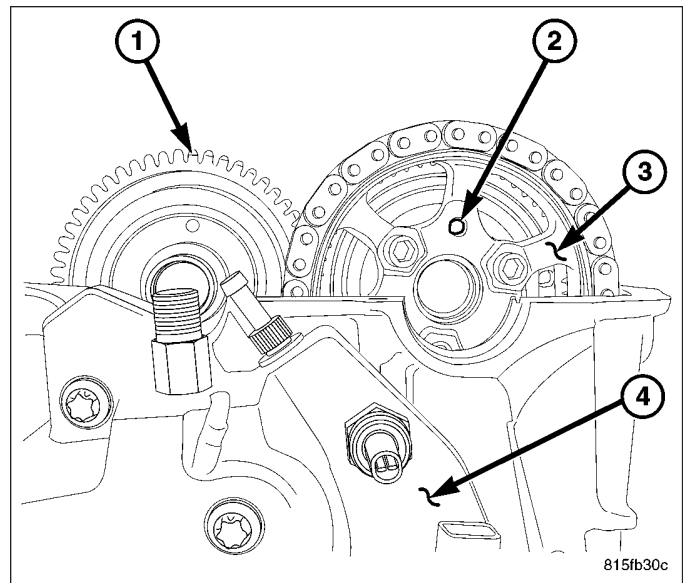


5. Remove the timing chain tensioner (3).

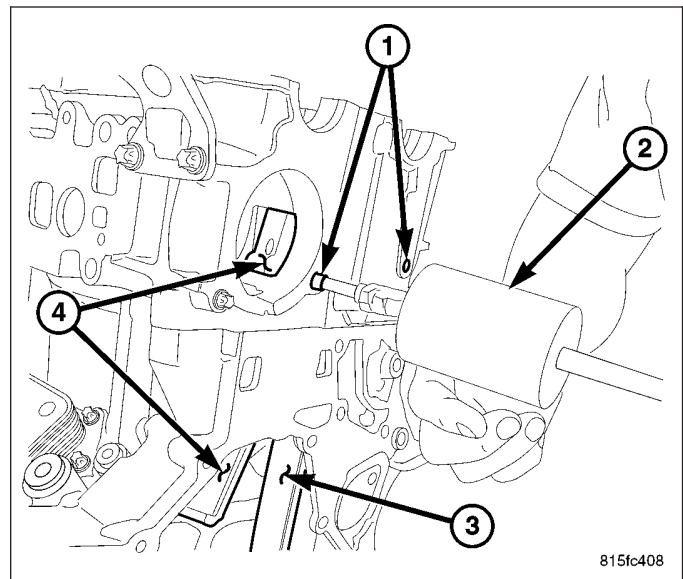




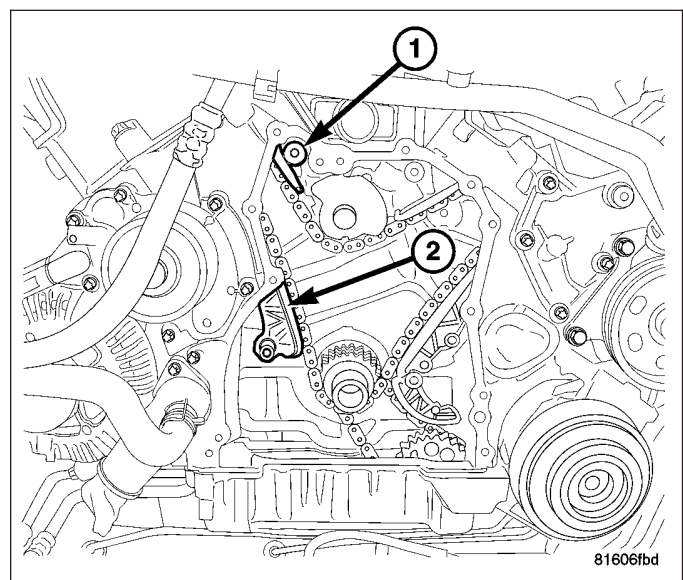
6. Rotate the engine and remove the right camshaft drive gear lower bolt.
7. Rotate the engine back to TDC and check the alignment marks at the balance shaft, camshaft gear and crankshaft gear.
8. Remove the remaining right camshaft drive gear retaining bolts.
9. Separate the right camshaft drive gear and chain from camshaft.
10. Remove the right camshaft drive gear.
11. Secure the chain so that there is slack at the timing chain guides but the chain remains on the crankshaft gear.



12. Cut a small section of tubing, with an inner diameter of the tube that is larger than the outer diameter of the timing chain guide pin, 25 mm (1 inch) in length.
13. Place the tube over the timing chain guide pin and thread a bolt into the timing chain guide pin in the right cylinder head. Tighten the bolt until the guide pin is removed from the cylinder head.



14. Remove the bolt for the left upper timing chain.
15. Remove the upper timing chain guide from the left cylinder head.
16. Remove the bolt for the right upper timing chain.
17. Remove the upper timing chain guide in the right cylinder head.

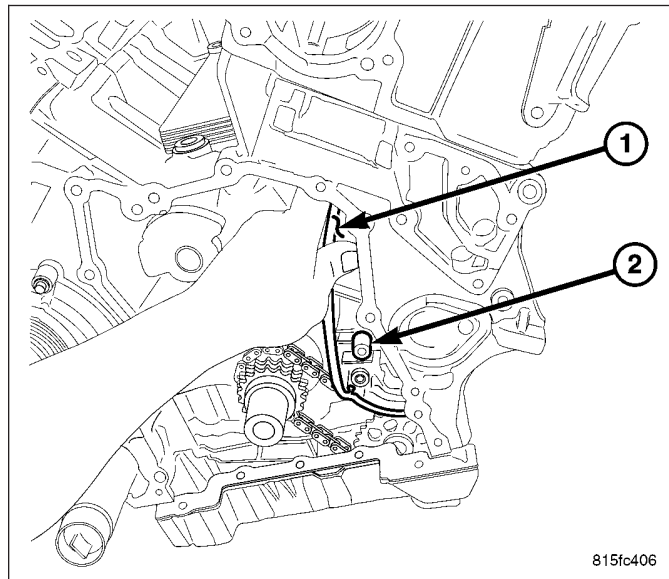




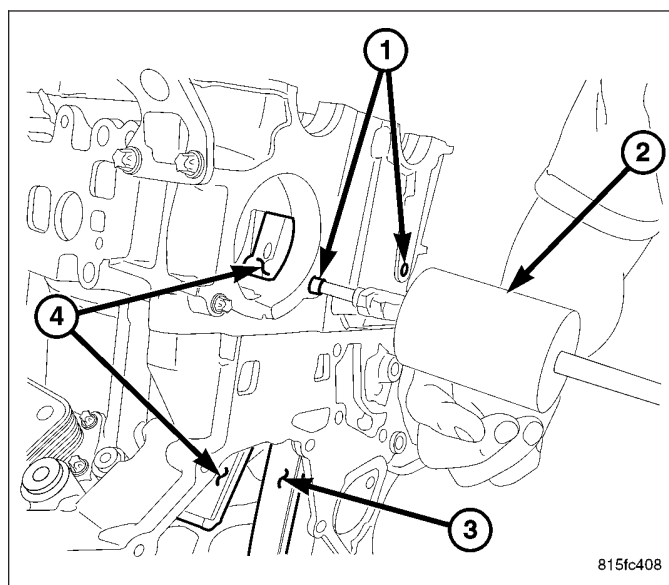
## TIMING CHAIN TENSIONING RAIL

1. Disconnect negative battery cable.
2. Remove cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).

**NOTE:** Remove timing case cover carefully. Care must be taken not to damage oil pan gasket.

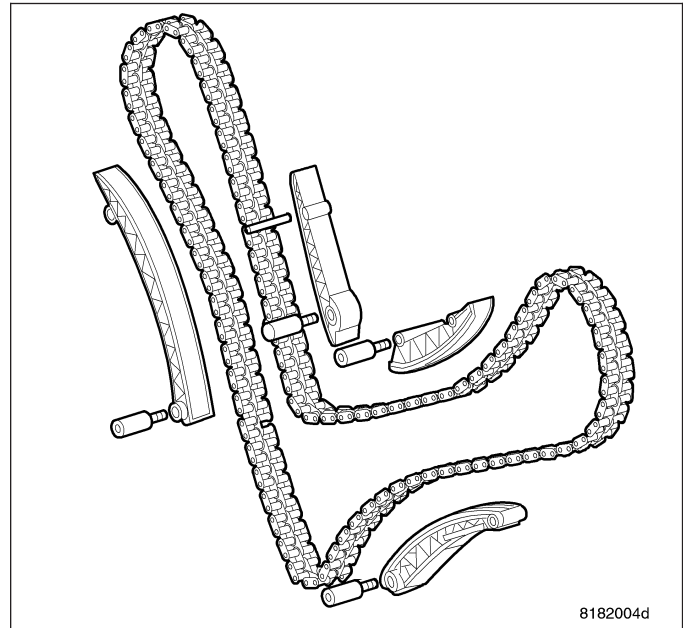


3. Remove timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).
4. Remove the timing chain guide pin.
5. Remove the timing chain retaining bolt.
6. Remove the timing chain tensioner.



## TIMING CHAIN

To check the timing chain for wear and stretch, remove the right-bank cylinder head cover and position the engine at TDC of cylinder number one. Lock the camshafts with special tool 8929 – Locking Pins. The timing marks on the camshaft gears must face each other. Rotate the engine in the direction of rotation only and do not turn back otherwise measurement errors can result. With the camshafts locked, check the position of the vibration damper. The chain stretch is measured by the number of crankshaft degrees past the TDC mark. The timing chain is OK when the belt pulley is at the marking at max. 11° after TDC with locked camshafts. Replace the timing chain has stretched beyond specifications.



1. Disconnect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Remove the left cylinder head cover. (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL)
3. Remove the right cylinder head cover. (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL)

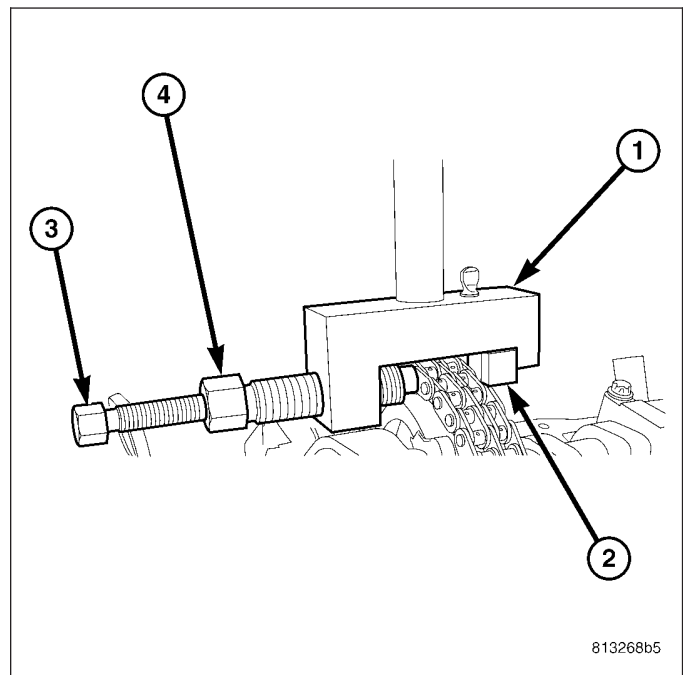
**NOTE:** Cover the timing chain area. Care must be taken not to drop any repair debris or pieces into the engine when separating the timing chain links.

4. Install special tool # 9525 using two of the cylinder head cover bolts.
5. Assemble special tool #9312–1 using 9312– 3 and 9312–4. Install insert #9312–13 and retain with screw provided.

**CAUTION:** Care must be taken not to drop the timing chain plates into the engine once the timing chain is separated.

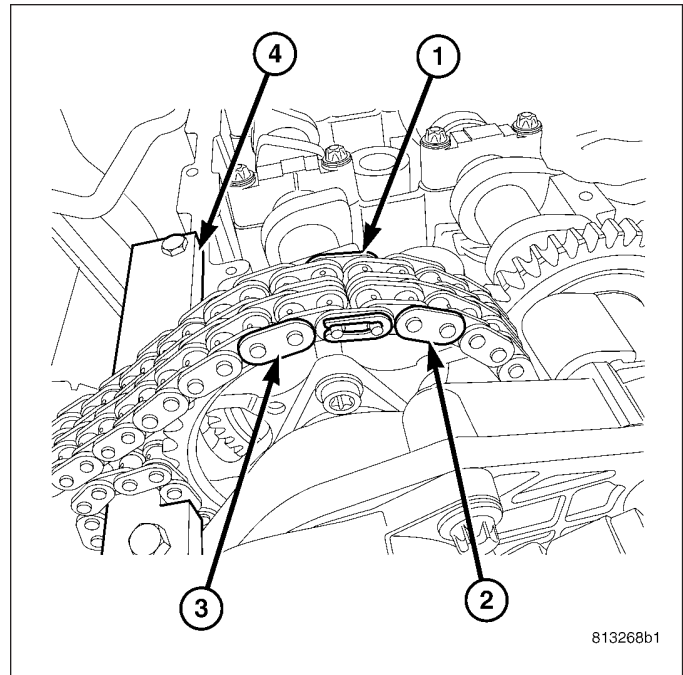
**NOTE:** When installing special tool #9312–1 onto timing chain link, be sure to back off the smaller nut of the thrust pin #9312–3 until the pin is recessed inside of the spindle, #9312–4. Screw the thrust spindle #9312–4 in until it is seated and aligned properly over the rivet of the timing chain.

**NOTE:** When fitting the thrust spindle, ensure that the thrust pin is positioned at the left timing chain pin of a chain link.



**NOTE:** Cover the timing chain area. Care must be taken not to drop any repair debris or pieces into the engine when separating the timing chain links.

6. Carefully turn the thrust pin #9312-3 of special tool #9312-1 clockwise while holding the handle until the rivet is pressed out and the chain is separated. Discard the loose link and plates.



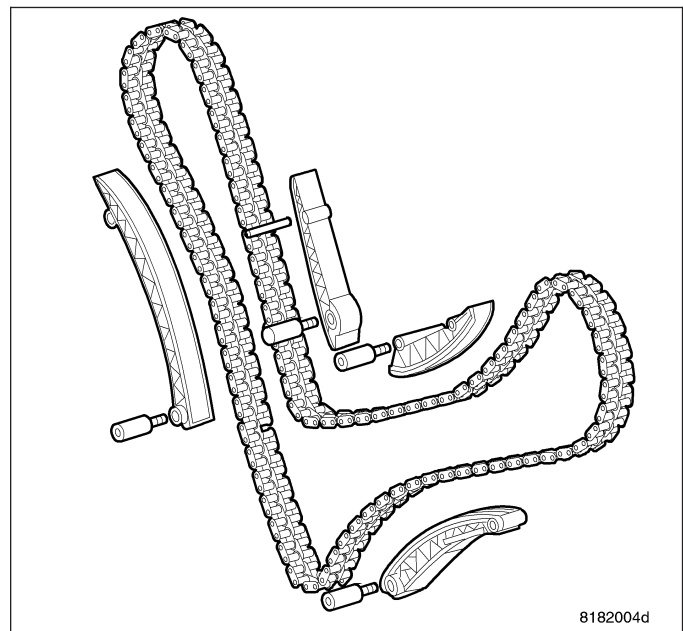
**NOTE:** One whole timing chain link must be removed.

**CAUTION:** IT IS ESSENTIAL that the installation procedure for the timing chain is followed exactly. Failure to do so will result in severe engine damage.

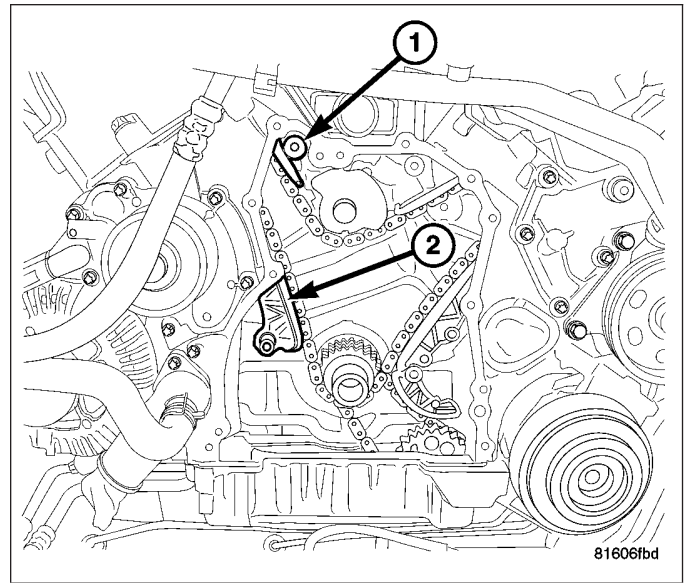
## INSTALLATION

### TENSIONING AND SLIDE RAIL

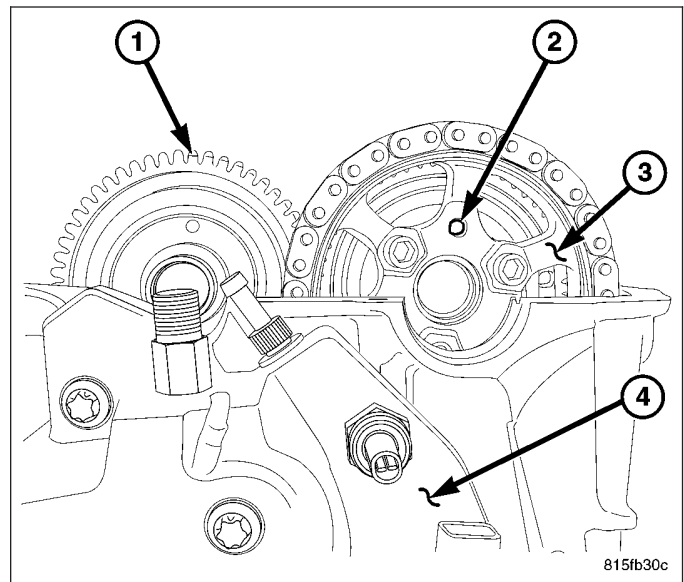
**NOTE:** Carefully clean all mating surfaces with appropriate solvents to assure that no grease or oil is present during reassembly.



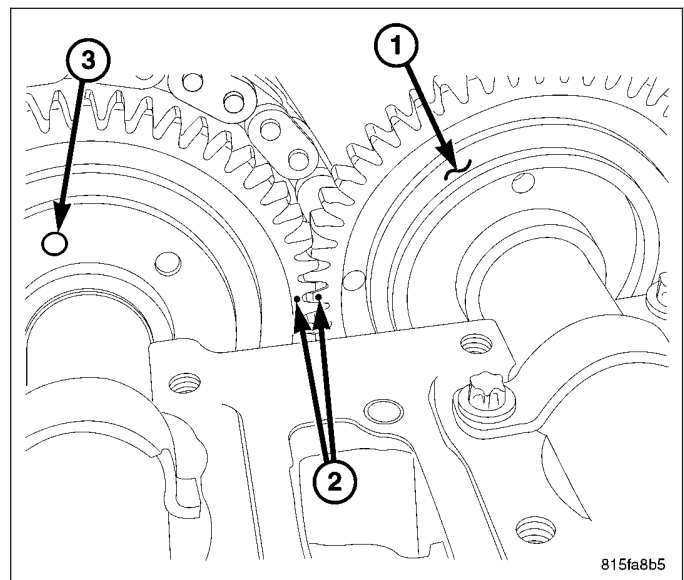
1. Install the right side upper timing chain guide and bolt (1).
2. Install the upper timing chain guide pin in the right cylinder head.
3. Install the left side upper timing chain guide and bolt.
4. Install the upper timing chain guide pin in the left cylinder head.



5. Install the camshaft drive gear on the exhaust camshaft in the right cylinder head.
6. Install the upper two bolts into the camshaft drive gear and tighten to 18 N·m (159 lbs.in.).



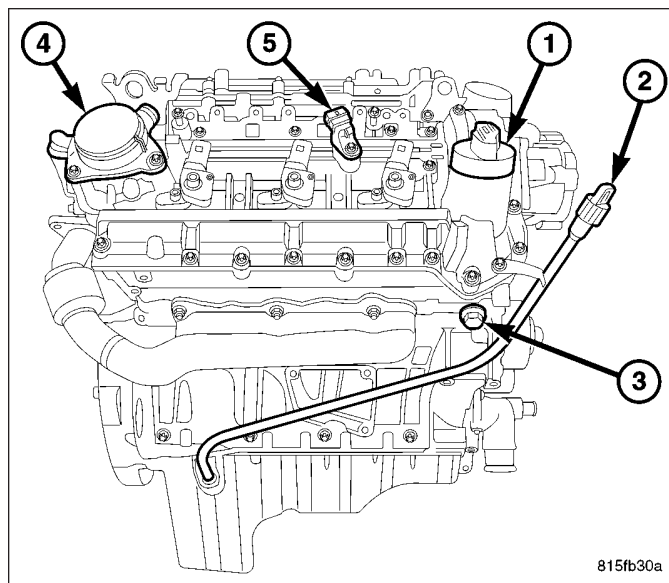
7. Be sure that all of the timing marks are correctly aligned. (Refer to 9 - ENGINE/VALVE TIMING - DESCRIPTION)
8. Rotate the engine and install the lower bolt into the camshaft drive gear. Tighten to 18 N·m (159 lbs.in.).



9. Install the timing chain tensioner and torque to 80 N·m (59 lbs.ft.).
10. Install the timing cover (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).
11. Install oil pan bolts. Tighten M6 bolts to 9N·m (80 lbs.in.) and M8 bolts to 20N·m (15 lbs. ft.).
12. Reconnect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - INSTALLATION)

**WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING. DO NOT STAND IN A DIRECT LINE WITH THE FAN. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR FAN. DO NOT WEAR LOOSE CLOTHES.**

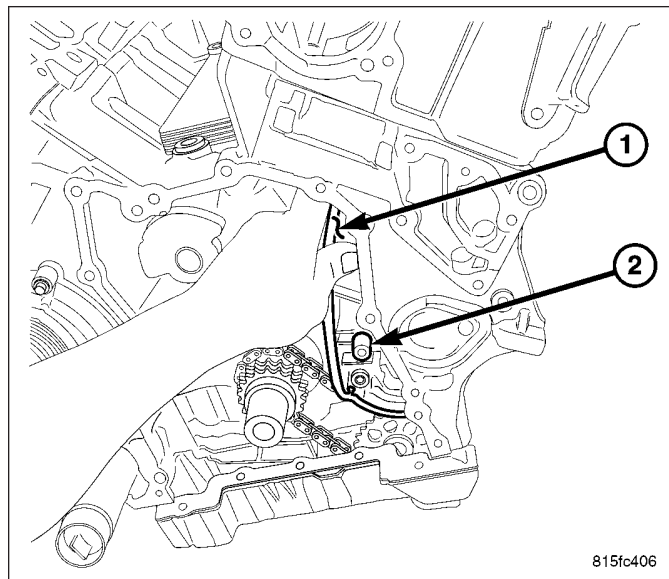
13. Start the engine, allow to warm, turn engine off and inspect for leaks. Care must be take to observe the fuel system warning. (Refer to 14 - FUEL SYSTEM - WARNING).



## TIMING CHAIN TENSIONING RAIL

**NOTE: Carefully clean all mating surfaces with appropriate solvents to assure that no grease or oil is present during reassembly.**

1. Install tensioning rail on bearing pin
2. Install the timing chain tensioner retaining bolt. Tighten to 12 N·m (106 lbs.in.)
3. Install timing cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).
4. Install oil pan and bolts. Tighten M6 bolts to 9N·m (80 lbs.in.) and M8 bolts to 20N·m (15 lbs. ft.).
5. Install cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).
6. Install the cylinder head covers. (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION)
7. Reconnect negative battery cable.



**WARNING: Use extreme caution when the engine is operating. Do not put your hands near the pulleys, belts or fan. Do not wear loose clothes.**

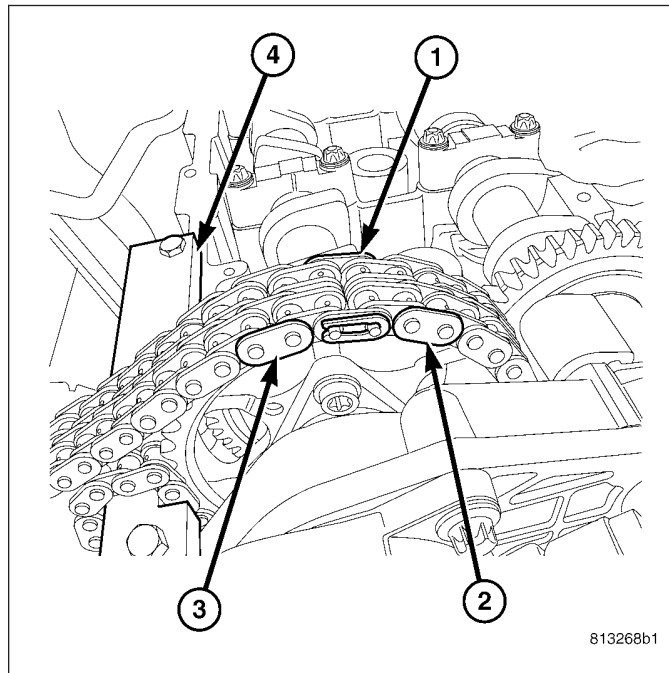
8. Start the engine and inspect for leaks. Care must be taken to observe the fuel system warning (Refer to 14 - FUEL SYSTEM - WARNING).

## INSTALLATION - TIMING CHAIN

**CAUTION:** IT IS ESSENTIAL that the installation procedure is followed exactly. Failure to do so will result in severe engine damage.

**CAUTION:** Cover timing case recesses to prevent foreign material from entering engine.

1. Connect new timing chain, oil hole side up and old timing chain with the assembly link, the assembly plate and the assembly locking element, and secure.



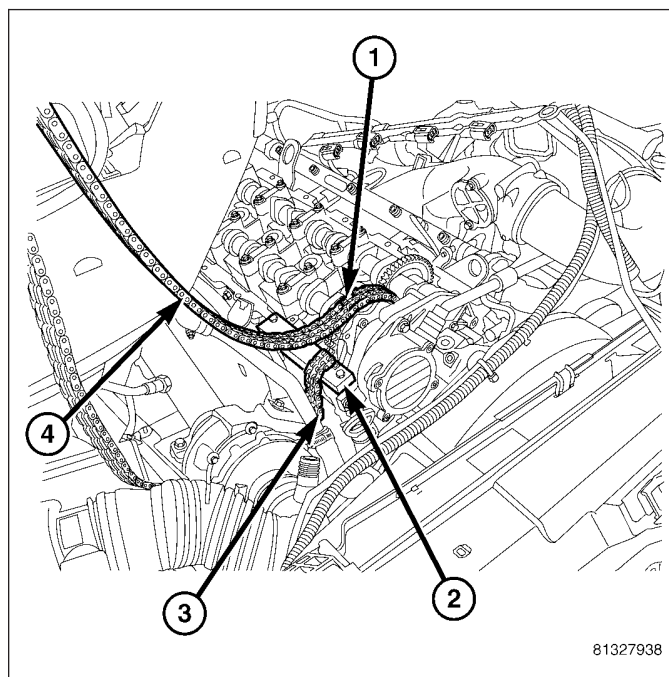
**CAUTION:** Always install the new timing chain with the oil holes pointing up. Failure to do so will result in severe engine damage.

**NOTE:** Always keep new timing chain meshed with camshaft sprocket.

**CAUTION:** DO NOT CRANK ENGINE and DO NOT ROTATE ENGINE BACKWARD. Engine rotation is clockwise, as you are looking at the engine. Rotate engine at crankshaft only.

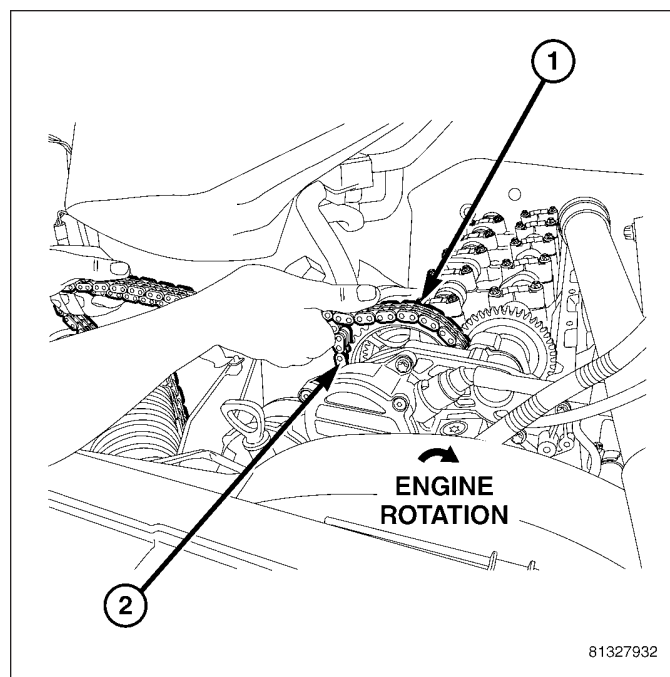
**NOTE:** Draw out the end of old timing chain evenly as it becomes free, to the same extent that new timing chain is drawn in.

2. Draw in new timing chain with the oil holes facing up, by rotating the crankshaft slowly in direction of rotation of engine.





3. Rotate the engine until the ends of the new timing chain meet and can be connected.

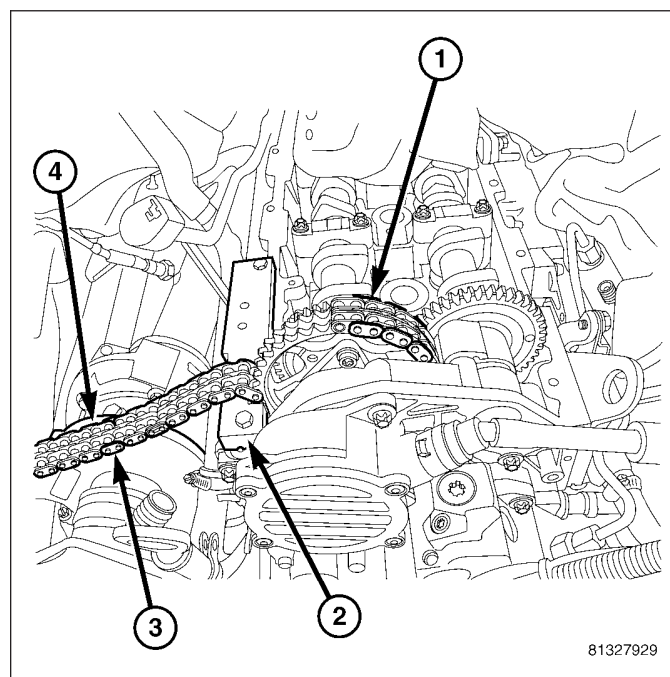


**NOTE:** Assembly link is only an assembly aid and NOT designed for engine running.

4. Remove assembly locking element, assembly outer plate and assembly link.

**CAUTION:** Cover timing case recesses to prevent foreign material from entering engine.

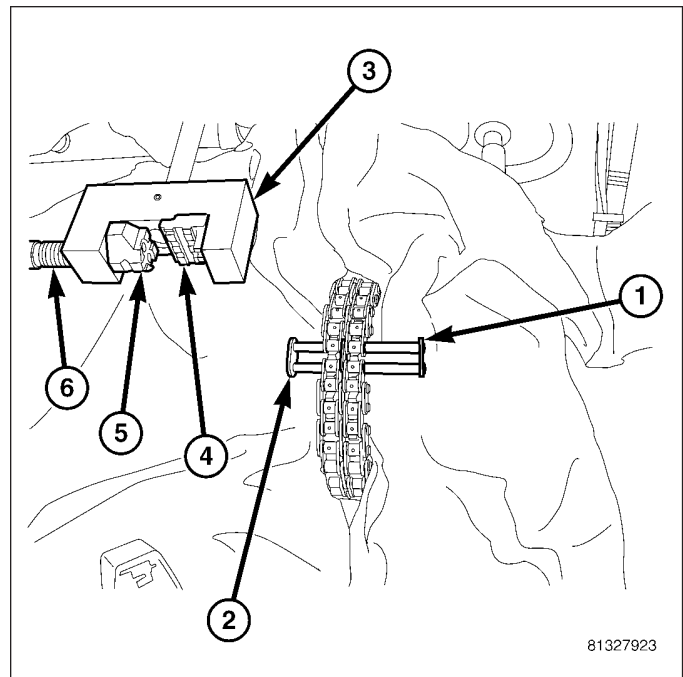
5. Insert new riveted link with the oil hole up, and new middle plate into ends of timing chain using the guide link to hold the middle plate in position.





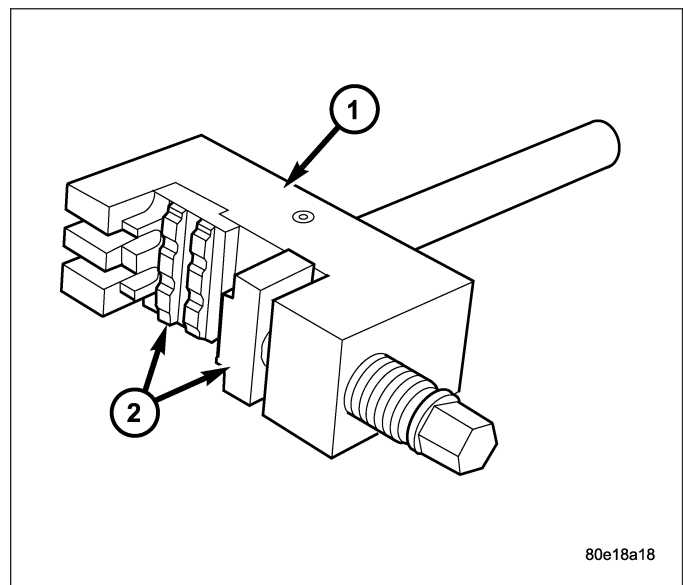
**NOTE: When assembling riveting tool, piece #9312-7 is secured by a screw and #9312-10 can move loosely on thrust spindle**

6. Assemble riveting tool by inserting pieces #9312-7 and #9312-10.



**NOTE:** Ensure that the riveted link and riveting tool are aligned.

7. Press in new riveted link as far as the stop.



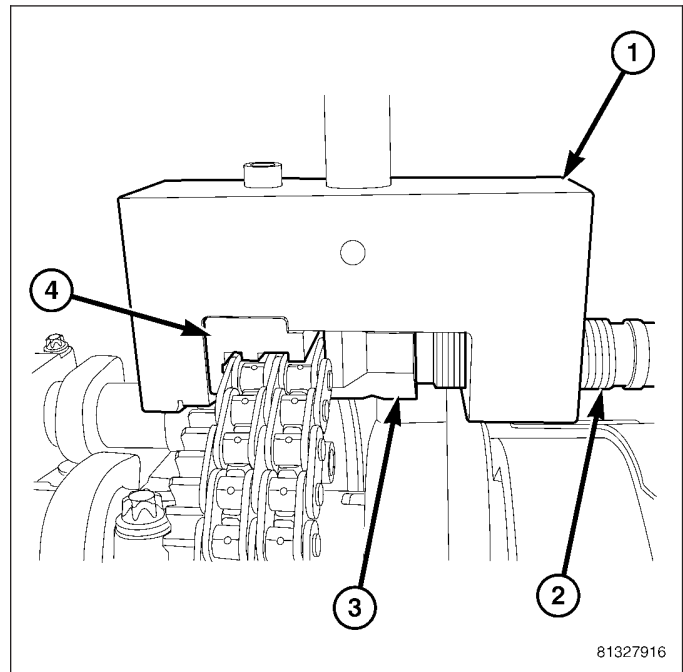
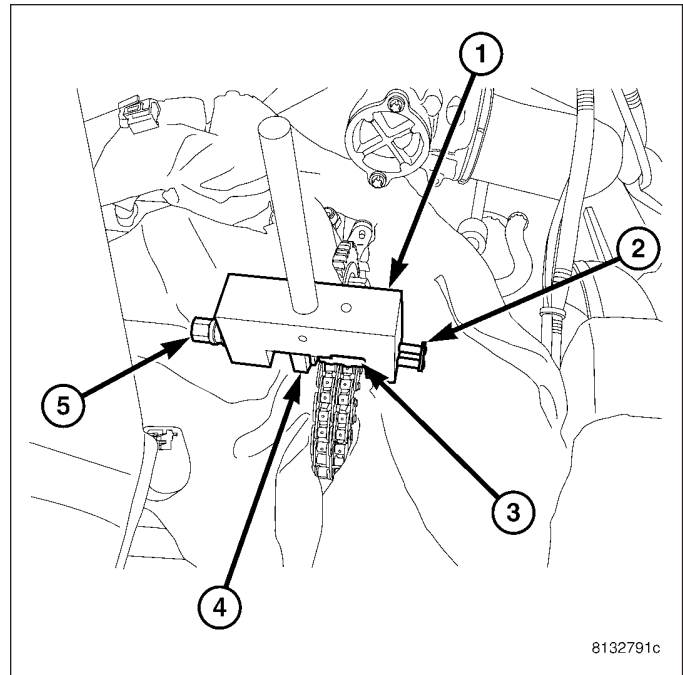
8. Remove guide link and riveting tool to change inserts.
9. Install insert #9312-6 on riveting tool and secure with screw.
10. Install insert 9312-8 on riveting tool.

**NOTE: The outer plate is held magnetically by riveting tool.**

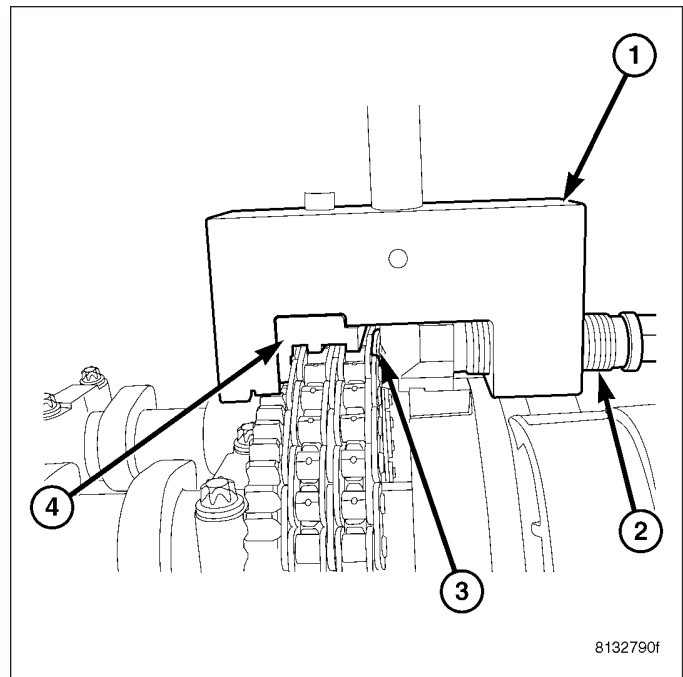
11. Insert new outer plate into the moving assembly insert.
12. Position riveting tool so that spacer webs of the guide are side by side.
13. Ensure that riveted link and outer plate are aligned.

**NOTE: When turning spindle of riveting tool, be sure that pins of riveted link are inserted into holes of outer plate**

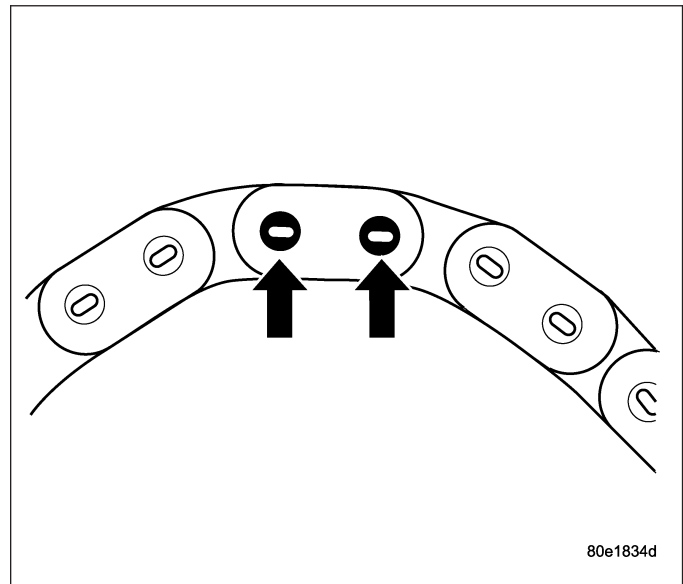
14. Screw in spindle of riveting tool until firm resistance is felt.
15. Remove riveting tool.
16. Install moving assembly insert #9312-11 to #9312-1.
17. Position riveting tool exactly over middle of pin.
18. Tighten riveting tool spindle to end of travel.
19. Repeat procedure for both riveting pins.



20. Inspect riveting, re-rivet if required.



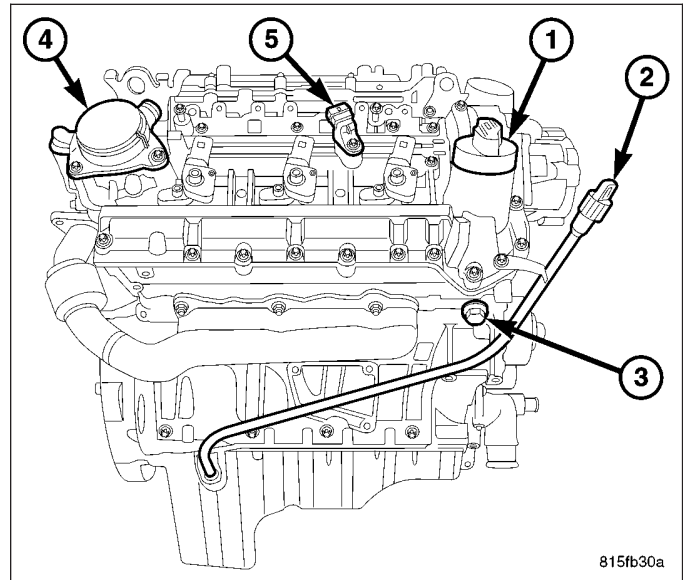
- 21. Install cylinder head cover (Refer to 9 - ENGINE/ CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).
- 22. Install engine cover (Refer to 9 - ENGINE - INSTALLATION).
- 23. Connect negative battery cable.
- 24. Start engine and inspect for leaks. Care must be taken to observe the fuel system warning (Refer to 14 - FUEL SYSTEM - WARNING).



## TENSIONER-TIMING CHAIN

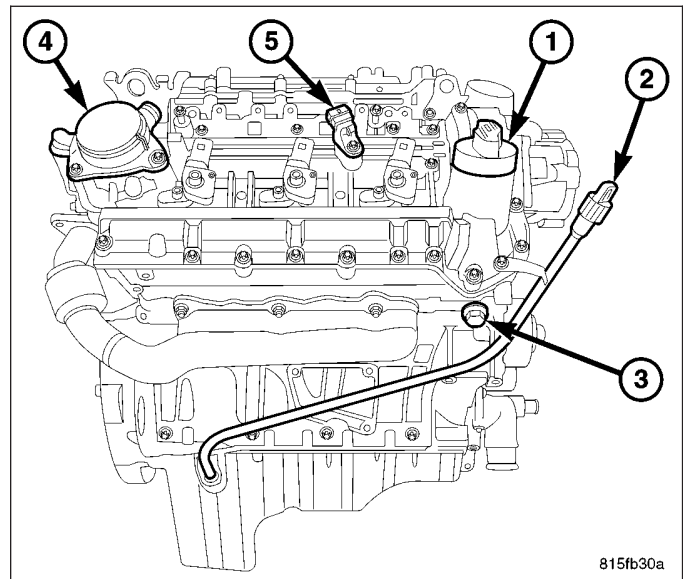
### DESCRIPTION

The timing chain tensioner is located on the right cylinder head. The tensioner is hydraulically operated with the adjusting portion riding on the right timing chain guide. Hydraulic support for the tensioner is supplied by forward oil passages in the right cylinder head.



### REMOVAL

1. Disconnect negative battery cable. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - REMOVAL)
2. Open hood.
3. Remove engine cover (Refer to 9 - ENGINE - REMOVAL)
4. Remove the engine intake air duct.
5. Remove air cleaner housing (Refer to 9 - ENGINE/AIR INTAKE SYSTEM/AIR CLEANER HOUSING - REMOVAL).
6. Remove the cable strap from the engine wiring harness.
7. Remove the timing chain tensioner.



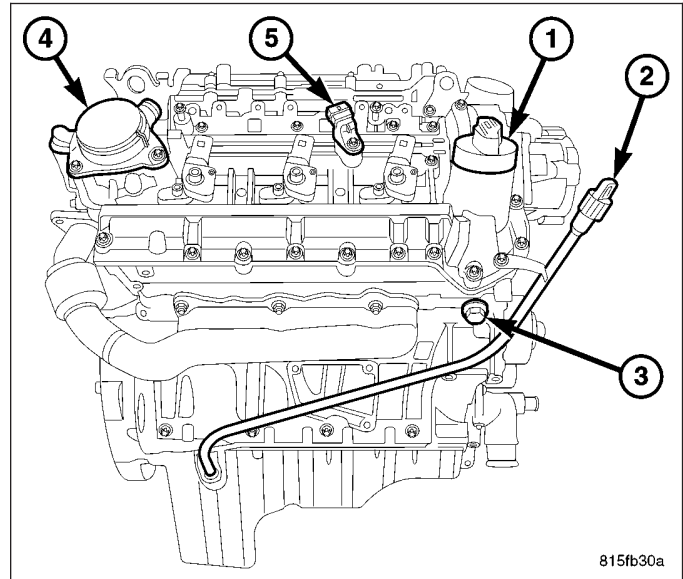
## INSTALLATION

**NOTE:** Carefully clean all mating surfaces with appropriate solvents to assure that no grease or oil is present during reassembly.

1. Install timing chain tensioner with new gasket. Tighten to 80N·m (59 lbs.ft.).
2. Install cable strap on the engine wiring harness.
3. Install air cleaner housing.
4. Install intake air duct.
5. Reconnect negative battery cable.

**WARNING:** Use extreme caution when the engine is operating. Do not put your hands near the pulleys, belts or fan. Do not wear loose clothes.

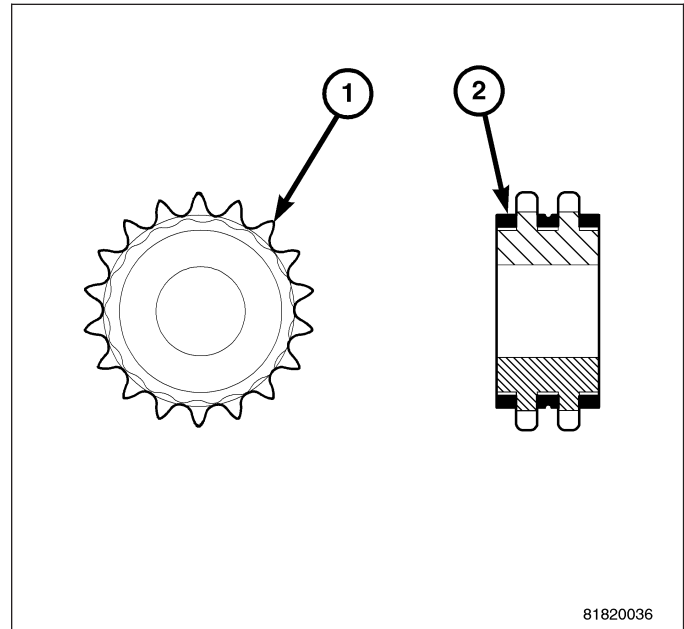
6. Start the engine and inspect for leaks.



## BALANCE SHAFT

### DESCRIPTION - BALANCE SHAFT

The balance shaft sprocket is made of steel and is mounted to the balance shaft with an interference fit. The sprocket is not serviceable and must be replaced with the balance shaft as an assembly. A layer of rubber is molded to the base circle of the sprocket to reduce chain noise. The notch on the front counter-weight must be at the 12 o'clock position when setting the timing.

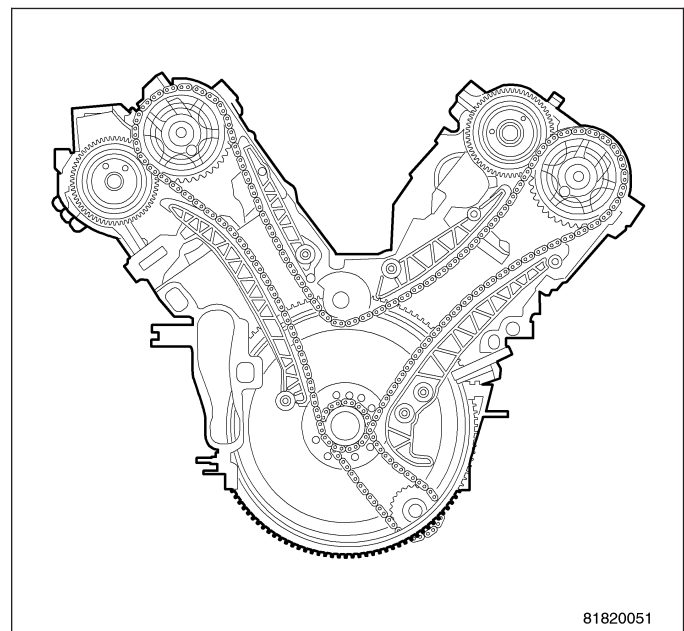


### REMOVAL - BALANCE SHAFT

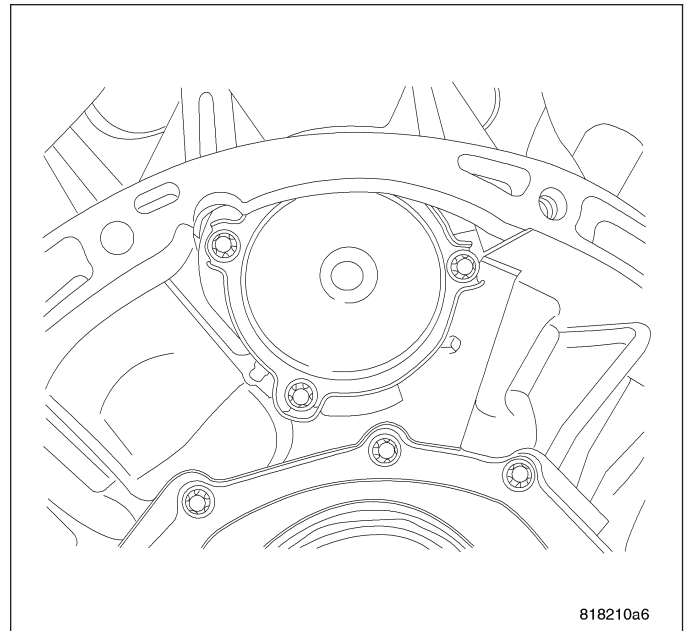
1. Disconnect the battery. (Refer to 8 - ELECTRICAL/ BATTERY SYSTEM/CABLES - INSTALLATION)
2. Remove the transmission and torque converter. (Refer to 21 - TRANSMISSION/TRANSAXLE/AUTOMATIC - NAG1 - INSTALLATION)
3. Position piston 1 to TDC.

**NOTE:** To set piston #1 to Top Dead Center (TDC), Rotate the engine at the crankshaft in the running direction. The markings on the camshaft sprockets must be positioned opposite each other. The markings on the camshaft sprockets must be aligned with the cylinder head and lie on the left side. The TDC marking on the vibration damper must be aligned with the stay on the timing case cover.

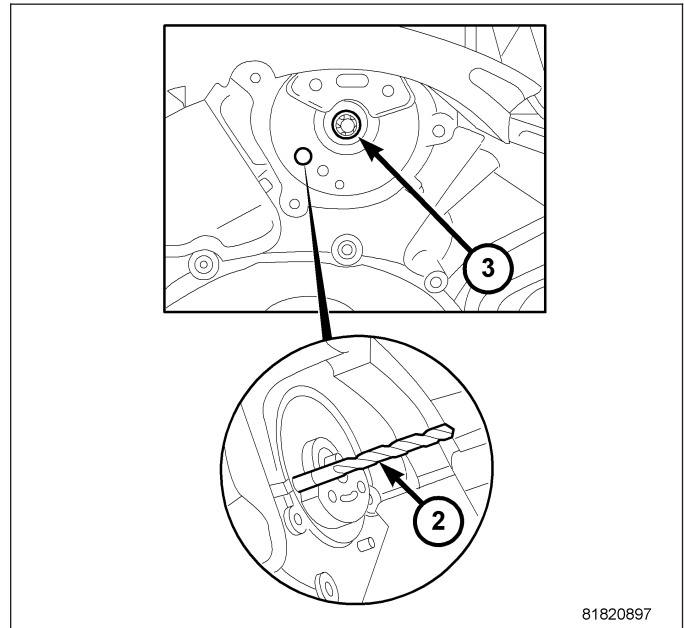
4. Remove the timing chain cover. (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL)



5. Remove the rear balance shaft cover.

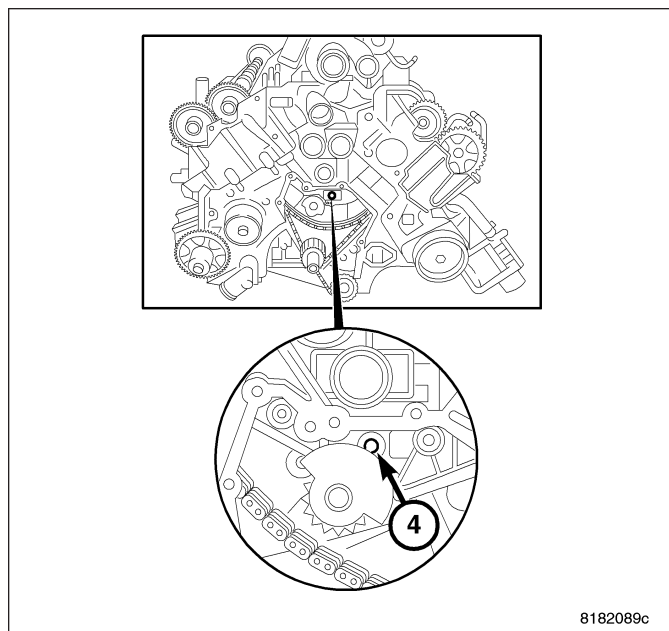


6. Install a 8.5 mm diameter drill bit (2) into the balance shaft stop.

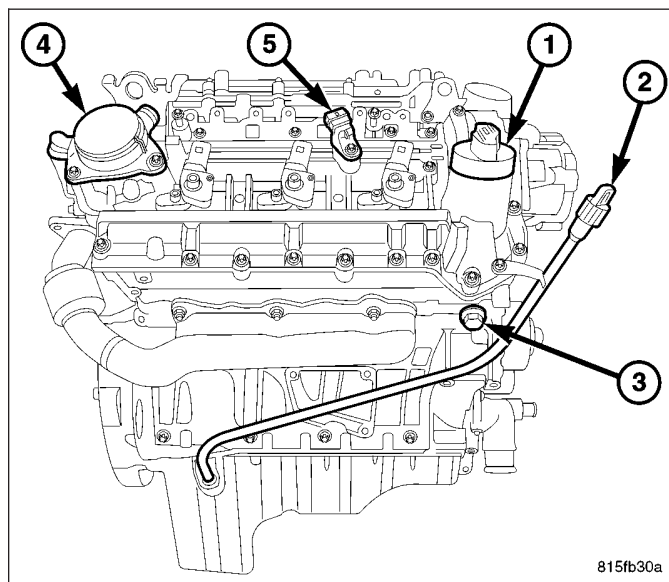




7. Make sure that the notch in the balance shaft front counterweight is at the highest point of the weight. If the balance shaft is aligned correctly, remove the drill bit.
8. Remove the bolt from the rear of the balance shaft.

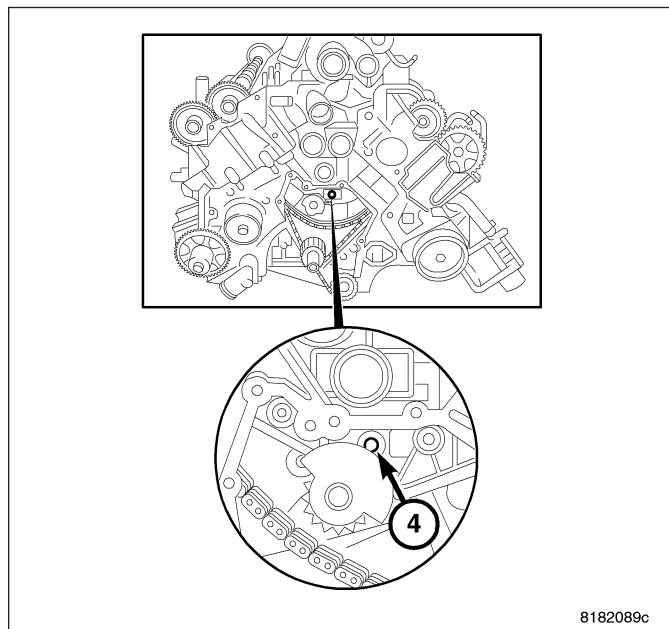


9. Remove the timing chain tensioner.
10. Remove the bolt from the front of the balance shaft.
11. Remove the balance shaft.

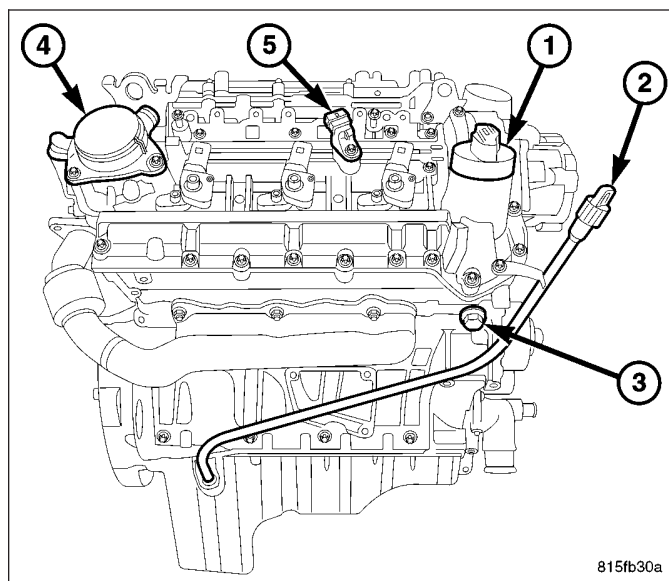


## INSTALLATION — BALANCE SHAFT

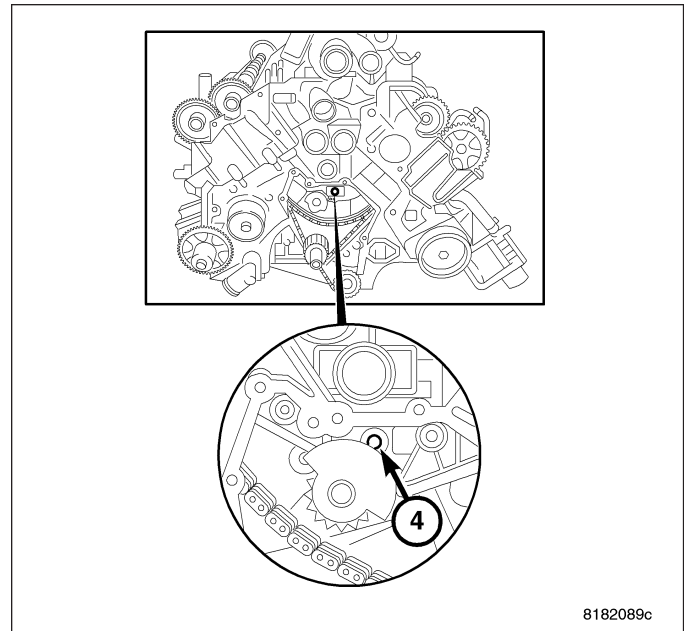
1. Install the balance shaft.
2. Align the balance shaft so that the notch in the counterweight is facing directly up.



3. Install the timing chain tensioner. Torque to 80 N·m ( 59 ft. lbs ).
4. Be sure that the camshafts and crankshaft are all set to their correct timing positions. (Refer to 9 - ENGINE/VALVE TIMING - DESCRIPTION)



5. Install the bolt in the front of the balance shaft.  
Torque bolt to 9 N·m ( 80 in. lbs ).



6. Install the bolt in the rear of the balance shaft 20 N·m (177 in. lbs ) and then rotate an additional 90°.
7. Install the rear balance shaft cover. Torque bolts to 8 N·m (71.8 in. lbs ).
8. Install the timing chain cover. (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION)
9. Install the torque converter and transmission. (Refer to 21 - TRANSMISSION/TRANSAXLE/AUTOMATIC - NAG1 - INSTALLATION)
10. Connect the battery. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/CABLES - INSTALLATION)

